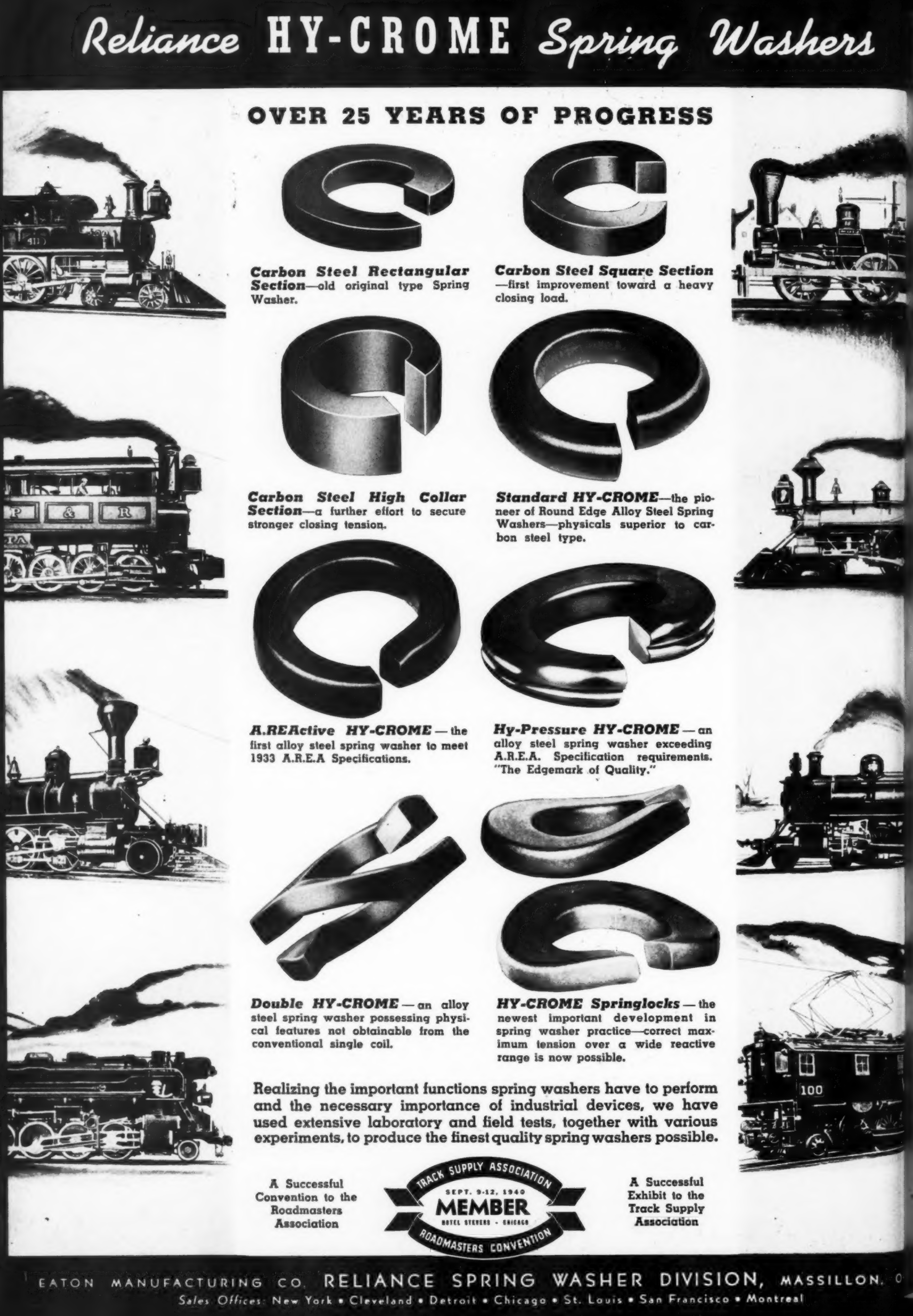
SEPTEMBER, 1940

Railway

ON THE WESTERN PACIFIC


Reliance HY-CROME Spring Washers
OVER 25 YEARS OF PROGRESS
Carbon Steel Rectangular Section—old original type Spring Washer.
Carbon Steel Square Section—first improvement toward a heavy closing load.
Carbon Steel High Collar Section—a further effort to secure stronger closing tension.
Standard HY-CROME—the pioneer of Round Edge Alloy Steel Spring Washers—physicals superior to carbon steel type.
A.REActive HY-CROME—the first alloy steel spring washer to meet 1933 A.R.E.A Specifications.
Hy-Pressure HY-CROME—an alloy steel spring washer exceeding A.R.E.A. Specification requirements. "The Edgemark of Quality."
Double HY-CROME—an alloy steel spring washer possessing physical features not obtainable from the conventional single coil.
HY-CROME Springlocks—the newest important development in spring washer practice—correct maximum tension over a wide reactive range is now possible.
Realizing the important functions spring washers have to perform and the necessary importance of industrial devices, we have used extensive laboratory and field tests, together with various experiments, to produce the finest quality spring washers possible.
A Successful Convention to the Roadmasters Association
TRACK SUPPLY ASSOCIATION
SEPT. 9-12, 1940
MEMBER
HOTEL STEVENS - CHICAGO
ROADMASTERS CONVENTION
A Successful Exhibit to the Track Supply Association
EATON MANUFACTURING CO. RELIANCE SPRING WASHER DIVISION, MASSILLON, O
Sales Offices: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Montreal

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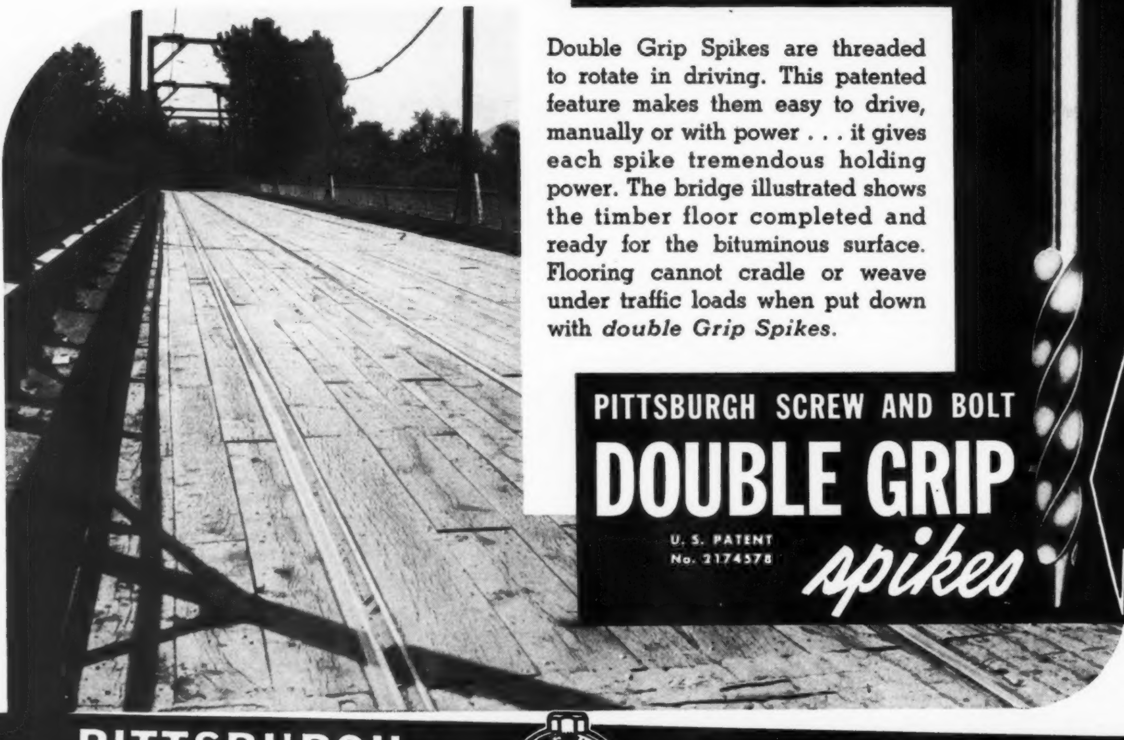
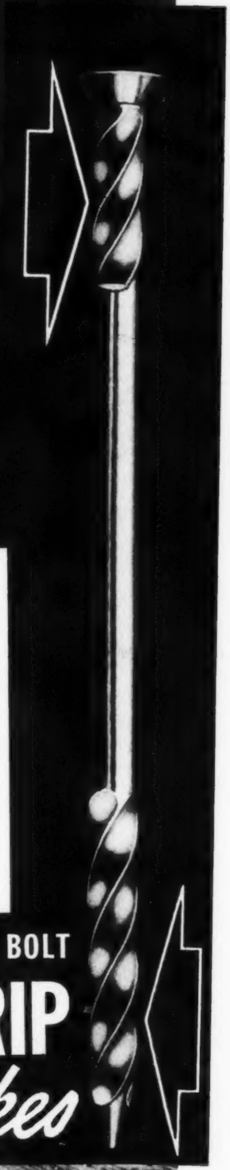
Easy

to drive...

and down to stay





Double Grip Spikes are threaded to rotate in driving. This patented feature makes them easy to drive, manually or with power . . . it gives each spike tremendous holding power. The bridge illustrated shows the timber floor completed and ready for the bituminous surface. Flooring cannot cradle or weave under traffic loads when put down with *double Grip Spikes*.

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U. S. PATENT
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at the Track Supply Association Convention

• End-hardening of new rail to retard batter is now standard practice for most railroads because it effects substantial reductions in joint maintenance expense. The Oxweld method of end-hardening rail in track produces a uniform, batter-resistant, rail end at low cost. By the Oxweld method, the work is performed efficiently, conveniently, and without interrupting traffic. A new motion picture which shows latest equipment and application of the Oxweld method, has just been completed. You are invited to see this film at Exhibit Areas 84 and 85, Hotel Stevens.

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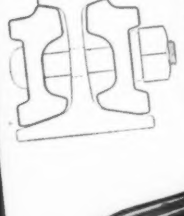
OXWELD RAILROAD SERVICE

SINCE 1912—THE COMPLETE OXY-ACETYLENE SERVICE FOR AMERICAN RAILROADS

"*Gentlemen,* I believe the

TIE PLATES
U·S·S Tie Plates and Track Fastenings—tie plates made to A.R.E.A. or special designs—track spikes in new or old A.R.E.A. designs—standard screw spikes—GEO Track construction.



JOINT BARS
U·S·S Rails, Joint Bars and Track Bolts — standard open-hearth steel rails — controlled-cooled, end-hardened and Brunorized, Joint Bars to fit new and old sections — track bolts.

TRACKWORK
U·S·S Lorain Trackwork—switches, frogs, and crossings in standard and special designs.

SWITCH STANDS
U·S·S Johnstown Switch Stands—modern designs assure efficient operation of yard and main line switches.

75 Years of Progress in the
ROLLED STEEL RAIL

Steel Rail is here to stay!”

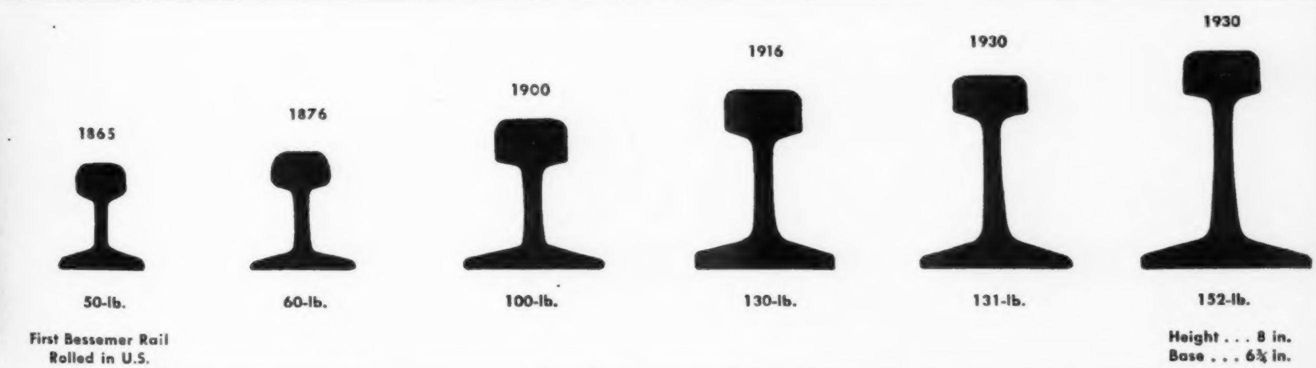
Seventy-five years ago when the first steel rail was rolled, railroad men and steel men agreed that it had a great future. But even the most optimistic of them could scarcely have foreseen the important place this rail was destined to occupy in the development of America's network of railroads.

These early pioneers would have scoffed at the thought of passenger trains traveling long stretches at 60 miles an hour. Today we have more than 400 such trains, many of which attain speeds over 100 miles an hour. And our freight trains, often a mile long, sometimes weighing as much as 12,000 tons, are running much faster than ever before.

But the greatest marvel of all can be expressed in one word—"safety." Today, the safest person in the world is a passenger aboard an American railroad train. At present safety rates, statisticians figure that an average passenger could travel at 60 miles an hour, continuously, for 3500 years, before catching up with Fate.

Contributing to these safety records has been the constant improvement in rail quality, particularly during recent years. Here is positive proof that rails, as well as wheels, axles, and other vital parts, are among the most perfectly made products manufactured today.

Ever since that first steel rail was rolled—by a mill which turned out to be one of the parents of Carnegie-Illinois — we have worked constantly that the rail may meet all requirements . . . that railroad progress be never retarded by the need for a better rail. This is our responsibility. We pledge continuance of the drive for rails that are better, stronger, longer-lasting and, above all, safe.



U·S·S STEELS *for* RAILROAD USE

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UNITED STATES STEEL

TO RAILWAY SUPPLY MANUFACTURERS

"A Complete Program"

"Boss, I'm certainly glad that you've arranged for us to exhibit at the Roadmasters' convention," said the star railway salesman to his sales manager.

"Why do you say that, Bill? You know that some of our brass hats aren't so hot about exhibits."

"I know that, boss, but they don't know these railway exhibits. I can give you a dozen reasons why we can't afford not to be there."

"All right, let's have some of them."

"In the first place, practically all of the men who attend the convention are customers or good prospects, many of them from points hard to visit, to whom we can tell our story and show our products. These contacts are as good as a call on them at their offices—and a lot cheaper."

"That's true."

"And, boss, we can't overlook the importance of reaching these men with our story at a time when their interest has been aroused by the reports and discussions on the convention floor. That's a natural build-up for us."

"I hadn't thought of that."

"Yes, and don't forget that these men come to the convention to study materials and methods; they have time to listen to our story and are receptive to our arguments."

"Yes, that's right."

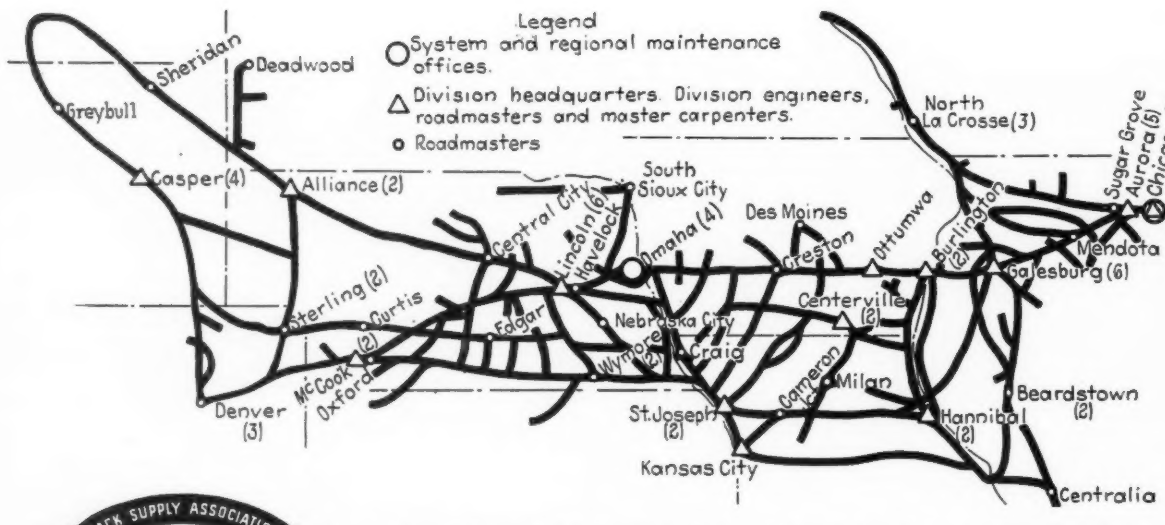
"And we can't ignore the fact that our competitors are there too; we can't afford not to be on the job when they're working on our customers, directors or no directors."

"That's enough. You've confirmed my judgment."

"And, boss, I want to add also that you're smart in taking extra space in the Roadmasters' convention issue of *Railway Engineering and Maintenance*, to put our story into print, for it'll follow these men home and clinch the arguments we give them at the show—and it'll carry our exhibit to those men back home who can't get away for the convention but who'll read that issue with its report of the meeting and exhibit with special interest."

"In other words, Bill, you think that our advertising rounds out our exhibit and the fine job of selling that you're doing?"

"That's it, boss. With a well-rounded program like that, we can't help getting results."



TRACK SUPPLY ASSOCIATION SEPT. 9-12, 1940 EXHIBITOR HOTEL STEVENS · CHICAGO ROADMASTERS CONVENTION

Railway Engineering and Maintenance Goes Every Month to 92 Supervisory Maintenance Officers on the Chicago, Burlington & Quincy at **2 System Headquarters, 13 Division Offices and 22 Other Supervisory Headquarters** Scattered All the Way from Chicago, Ill., to Denver, Colo., and Greybull, Wyo. This Magazine Also Goes to 87 Other Subordinate Officers Who Are in Training for Promotion to Supervisory Positions on This Railway.

RAILWAY ENGINEERING AND MAINTENANCE IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

No. 141 of a series

Railway
Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING CORPORATION

105 WEST ADAMS ST.
CHICAGO, ILL.

September 1, 1940

Subject: The Roadmasters' Convention

Dear Reader:

"How can I justify the expense of sending some of our roadmasters to the convention next month? Our management is hard to convince in matters of this kind, and I will appreciate your observations as to the benefit derived by these men from attendance at this meeting." This was the essence of a request that I received recently from the chief engineer of an important railway. Anticipating that the question that he raised is in the minds of not a few other supervisory maintenance officers, I quote from my reply in part, as follows:

"I have attended the conventions of the Roadmasters' Association for more than thirty years, without a break. I have also worked intimately with the men who have served this association as officers through these years. I know first hand, therefore, of the character of the leadership that this organization has enjoyed.

"I know of no organization whose members take a keener or more active interest in the reports and papers that are presented than at this convention. The discussions are exceedingly spirited at times and are intensely practical. In recent years, recognition of this fact has been growing, with the result that an increasing number of higher engineering officers are also attending the conventions to get first-hand information regarding the details of track work from men who know these details.

"Within the last ten or fifteen years, the reports and addresses presented at this convention have been of exceptionally high quality, reflecting the higher caliber of men who are entering track work. As a result, the programs of this association today compare well with those of any other railway association for quality of information as well as manner of presentation.

"The convention is a working convention, with morning, afternoon and evening sessions. The men who come, therefore, come for business rather than relaxation and invariably win high commendation from executive officers who drop into the meetings because of this fact.

"An especially valuable feature of the convention is the exhibit presented by some 50 or 60 manufacturers of materials and equipment used in roadway maintenance. This exhibit is unusually practical for the track man, since it is confined to his needs. I never lose interest in watching these roadmasters going over equipment to determine its merits."

Are those of you who are in high supervisory positions arranging for adequate representation from your roads? Are you taking advantage of the opportunities presented by this convention and exhibit?

And don't forget that the Bridge & Building convention, on October 15-17, offers the same opportunities to those men who are interested in and responsible for the construction and maintenance of bridges, buildings and water service facilities.

Yours sincerely,

Elmer T. Howson

ETH:EW

Editor

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for Year Around Economy

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One BARCO tytamper will break up all of the ice four men can remove.

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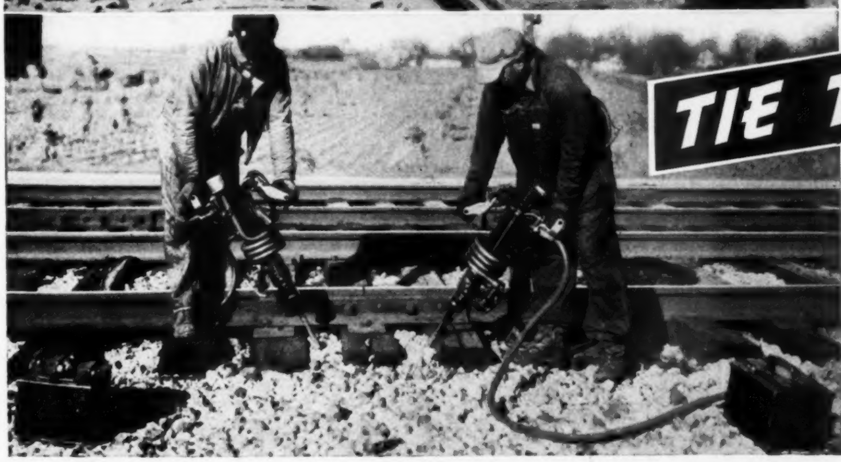
BARCO tytampers loosen cemented or frozen ballast quickly and easily.



TIE TAMPING

On 64 Railroads—5 years' satisfactory service.

TRACK SUPPLY ASSOCIATION
SEPT. 9-12, 1940
EXHIBITOR
HOTEL STEVENS - CHICAGO
ROADMASTERS CONVENTION

SPACE 70

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A New Nordberg RAIL DRILL

- Greater Convenience
- Faster Drilling

The Model BD Rail Drill is an entirely new design in which has been incorporated features that provide *greater simplicity, faster drilling* and *more convenience in handling.* Getting "set up" for drilling is extremely simple and can be done by the class of labor regularly used for track work. There is no time lost in readjusting the setting when changing from hole to hole. When moving to a new location, the machine is raised on the flanged rollers of the supporting arms and pushed along the rail, in fact, while the drill is in use it is never removed from the rail. The chuck for taking flat bits automatically tightens in position, no tools being required. These and other features make the new Model BD Drill the fastest and most convenient machine available today for drilling rail.

The powerful ratchet hand feed assures positive control of the feed and fast drilling.

The drill is pushed along the rail on the rollers and stabilizing bar.

TRACK SUPPLY ASSOCIATION
SEPT. 9-12, 1940
EXHIBITOR
HOTEL STEVENS · CHICAGO
ROADMASTERS CONVENTION

Visit our booth and see this new rail drill. Look at its new features. See how easily it handles.

NORDBERG MFG. CO.

MILWAUKEE
WISCONSIN

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Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE

SEPTEMBER, 1940

Railway Engineering and Maintenance

Rail

An Anniversary of Public Concern

ON May 24, 1865, the first steel rail to be rolled in America was produced at Captain E. B. Ward's rolling mill in Chicago. Although that event received only two column inches mention in the daily newspaper of that day, it marked the beginning of a development that has made possible our vast system of railways in America. Even more far reaching, it set in motion a chain of events that contributed largely to the development of the agricultural and industrial resources of America.

This incident is little known and less appreciated among railway employees; it is unknown to the public at large. It is for this reason that we are devoting a large part of the editorial pages of this issue to the recognition of the seventy-fifth anniversary of this event.

Removed a Barrier to Expansion

When Captain Ward's original plant was established in 1857, it had a capacity of 100 tons of iron rails a day, an output so small as to render impossible any appreciable expansion in railway mileage, even with the light sections then in use. Yet the new rolling procedure so effectively removed this barrier that, thirty years later, this plant and two others added in the same organization produced 793,000 tons of rails. And the output of these and other rail mills has continued to expand until 3,603,769 tons of rails were rolled in 1926.

It is commonly recognized that our railways have made possible the development of America, with its vast areas and great distances, for it was not until they struck out from the Atlantic seaboard across the mountains onto the prairies of the West that the settlement of these great agricultural areas became possible. Throughout the vast open spaces the railways preceded the settlers and made possible their location in and their development of these areas. And as coal, minerals and other natural resources have been opened up and as industries have developed, it has been the availability of rail transportation that has made possible the delivery of their products to distant areas of consumption in competition with products from other areas and countries. In other words, it has been the railways that have joined widely separated areas into a common country.

And as a railway can be no better than its track, the track likewise can be no better than the rail. Through the years, it has been the rail, more than any other unit in the roadway structure, that has constituted the limiting factor in railway development. Until a decade or two ago, designers of locomotives, and to a lesser extent of cars also, have been forced to confine their weights to those which could be carried safely by the rail. And these limitations have in turn fixed the lengths of trains, or the tonnage, that these locomotives could haul. And since it is the size of trains that determines, in large measure, the cost of transportation service, the relation of the rail to the cost of the transportation service that industry must bear is evident.

It is true that railway development in this country did not wait for the appearance of the steel rail, for there was a considerable mileage of railways in operation when Captain Ward rolled his first steel rail. Yet it was the development of a practical method of rolling steel rails that enabled them to be produced in sufficient quantities and at a sufficiently low cost to make possible the tremendous expansion in railway mileage in the half century following the Civil War. Without it, the building of thousands of miles of lines in this country year after year could not have occurred.

Still Other Considerations

The development of a means for rolling steel rails is of great public interest and benefit for another reason. To the patron, safety of transportation of person and property is paramount. Here the contribution of the rolled steel rail is noteworthy, for through developments in processes of production and in metallurgy a rail is being produced that is far superior to that available in any previous period. Much of this progress has been made within the last few years, credit for which is due the rail manufacturers and railways alike for their united co-operative attack on the problems.

There is still another standpoint from which the rail is of major importance to the railways; namely, that of the magnitude of their investment in rails and accessories, including fastenings, frogs, switches and crossings. For these materials, the railways have invested more than $2,700,000,000 for more than 56,000,000 gross tons of rails, together with the necessary fastenings, frogs, switches and crossings in the more than 275,000 miles of first and multiple main tracks and in the more than 125,000 additional miles of yard and side tracks. This is more than 10 per cent of the entire investment in railway

facilities. And this investment is still increasing as the railways become increasingly conscious of the economy of still heavier sections of rail than those now employed.

The story of rail progress, as described at length on the following pages, is one of distinct achievement for steel manufacturers and railways alike. While there are still problems to be solved, the progress that has been made in the last few years and the energy with which further studies are being prosecuted insure that these problems are well on the way to solution. With this record of achievement, and with the protective measures that are being thrown around the occasional defective unit, the rail has ceased to present a limit to the further progress of transportation. It is no mere coincidence that, as this development has occurred, the railways have entered a new and revolutionary era in their history of service with speeds previously unthought of in handling freight as well as passenger traffic.

Maintenance Forces

Must Guard Against a Shortage of Labor

WITH more than 9,000,000 persons still unemployed in the country, it may seem out of place to recall the problems arising out of the shortage of labor which confronted the railways during and for a number of years following the first World war, and to sound a warning to maintenance men that similar conditions, even if to a lesser extent and of somewhat different character, may soon confront them as a result of the government's rearmament and preparedness program, and which will certainly confront them if the United States becomes involved in war. Every maintenance of way officer who went through the earlier years of labor shortage knows the problems which such a shortage presents—the loss of many of the younger and best men, heavy force turnovers, reduced efficiency and increased accident hazards, in addition to the problem of keeping abreast of generally enlarged maintenance programs which are brought about by the same conditions which cause labor shortages.

That the maintenance of way department, with the smaller number of men required today to handle the same volume of work, as compared with the earlier period, will feel the pinch in ordinary labor to the same extent as formerly, is highly unlikely under any conditions that may develop, but that it might be affected and handicapped by a shortage in men best qualified to operate and maintain the mechanical equipment so widely used in and essential to maintenance operations today, and especially men rated as mechanics, is a serious possibility. This applies to men engaged in bridge, building and water service work as well as in trackwork, as is illustrated by the difficulty experienced by one road already securing two water service mechanics. This road, after bulletining these positions for more than a month without success, turned to its mechanical department for men, only to find that that department was also concerned about maintaining the adequacy of its forces, having found that many of its furloughed men, on whom it had counted to build back its forces as conditions warranted, had taken employment in a government arsenal and were no longer available for re-employment.

If this situation prevails at this early stage of our preparedness program, it warrants maintenance officers in giving it serious thought to insure that no lack of foresight on their part will handicap them unnecessarily in having an adequate force of men qualified to operate and maintain the large amount of equipment upon which efficient maintenance and train operation today depend.

Destroying Weeds

Wide Choice of Methods Available Today

METHODS of weed destruction, like the methods used in the performance of almost every other operation connected with railway maintenance, have changed radically during the last two decades. Men still in service can recall from experience the back-breaking labor of hand weeding in stone ballast and how hands that were heavily calloused from the rough work of the section became acutely sore from pulling plants that developed an astonishing resistance to removal. They also recall the hot and dusty work of swinging a scythe that seemed to grow dull almost before they had opened a swath, and how for mile after mile they brought into play muscles that were little used at other times.

It is true that at that time the mowing machine had substantially reached its present state of perfection and it was not uncommon for authority to be given to hire these machines locally where they could be obtained or could be used for cutting the right of way, for experience had shown that the machines could do the work in one-fourth of the time required for hand mowing and at a comparable reduction in cost. However, even where machines were used, it was seldom considered practicable to mow the slopes of high embankments or to cut close to the shoulder of lower ones, while it was necessary to keep clear of ditches and other obstructions, so that, in general, under the most favorable conditions, the section forces were compelled to do considerable hand mowing.

In those days, when the section allowance was "a man to the mile" and wages were far below their present level, there was little economic incentive to go further in the development of substitutes for hand methods than the use of the horse-drawn mowing machine for cutting the right-of-way. Yet even under these conditions of ample labor and low wages, the cost of the weeding of the track by hand was unreasonably high, and efforts were made to develop chemical methods of weed destruction. This was followed shortly by a scheme for killing weeds by the application of high-pressure steam. These and other suggested substitutes for hand methods made little headway, however, until the World War brought on a labor shortage and wages began to advance rapidly.

As a result of the demand thus created for methods of weed destruction that would stop or reduce these rapidly rising costs, chemical weed destruction met with immediate favor and no longer had to struggle to maintain a foothold. Not a few manufacturers became interested and, shortly, many machines were designed to do in different ways the basic job of keeping weeds out of the roadbed. As a result of this activity, the maintenance officer of today has available for his needs machines that will meet any condition with which he is faced, including

chemical spraying, burning, discing, scarifying and mowing.

By means of track mowers he can cut one or two swaths outside the rail and by means of tractor-drawn mowing machines or tractor mowers, the remainder of the right-of-way can be kept clean. The contrast with former methods and the development of machines for killing weeds have been discussed in some detail for this is one of the few maintenance operations that have become fully mechanized. A right-of-way that is not too hilly to prevent the use of a mowing machine and that is free from brush and stones can be kept clear of weeds without the use of hand labor, other than is required to clean around poles and timber bridges for fire prevention purposes.

Furthermore, despite the marked advance in wages during the 30 years that these developments have been under way, and the investment in and upkeep of the weed-destroying machines in use, this is being done at only a fraction of its former cost. While weed-destroying machines afford a clear-cut illustration of the economies that can be effected through mechanization, there are many other types of work equipment that demonstrate comparable economies, and the day is approaching when no railway can afford to do by hand what can be done as well or better by a power machine.

Tie Renewals

An Opportunity for Large Savings

ACCORDING to present prospects, more than 47,000,000 crossties will be renewed in the tracks of the railways of the United States during the present year. This will represent the largest single item of track maintenance work carried out, and, as such, offers one of the largest possibilities for reducing maintenance costs. This is true not alone because of the magnitude of the operations involved, but also because, in spite of the study and attention which have been given to tie renewals, this class of maintenance work has resisted modern production methods and the aid of work equipment longer than practically all others.

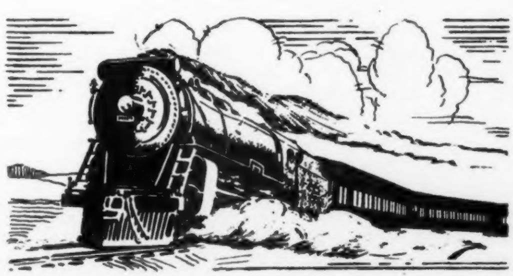
Since the early days of railroading, the work of renewing ties has been considered on most roads to come within the province of the section gang, a fact which, no doubt, in itself offers much resistance to any proposed change in practice, especially since there are few who will question the high quality of the work done by the average capable section gang, with continuing responsibility for each item of work which it performs. However, a number of roads today are finding that specialized tie renewal gangs, especially for territories involving heavy renewals, can carry out the work more economically than the average section gang, largely through the elimination of lost motion and unproductive time, and less overhead for supervision. They are also demonstrating that there need be no justification for the claim or fear that the production methods of extra gang forces necessarily result in inferior work, and that, on the other hand, the larger specialized gangs, properly supervised, will turn out high quality work along with their increased and more economical production. On these roads, it has not been overlooked that there is a relatively fine line of demarcation between the effectiveness and economy of the one type of organization and the other, depending upon the number of ties to be renewed per mile and other local conditions. This fact warrants special recognition, as it is evident that they have analyzed their methods and costs carefully and have so adjusted their practices that the most effective and economical organization is employed under the particular conditions prevailing on each specific territory.

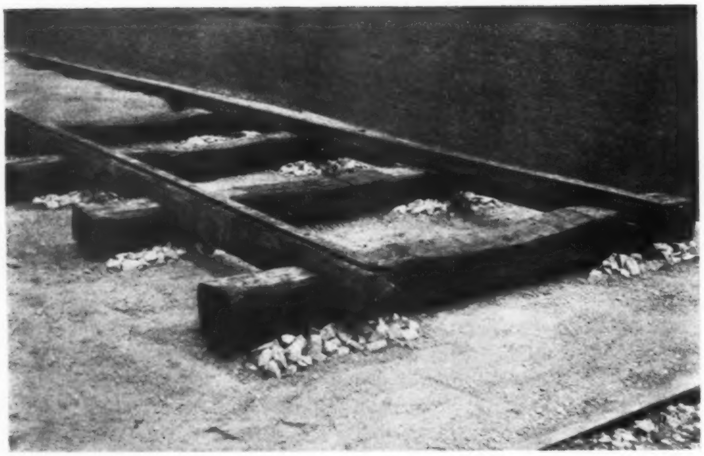
Of equal importance with the matter of gang organizations in efforts to effect economies in tie renewal work, is consideration of mechanical aids to assist in this work, a factor which has all but been neglected on many roads. It is true that repeated failures in attempts to develop fully effective mechanical aids for tie renewal work have deluded or disappointed railway officers on so many occasions that, in spite of their increasing receptiveness to equipment in general, they have become particularly skeptical with respect to newly developed units of equipment designed to assist in making tie renewals, and may be inclined to give them less attention than their merit warrants.

However, the question may well be raised as to whether they can afford to adopt this attitude.

There is, obviously, a limit to the extent of the consideration which can be given to new equipment through its development stage. On the other hand, and especially in the case of equipment designed to cut the cost of tie renewals, where the possibilities for savings are so large, maintenance officers can ill afford to overlook any possibilities in the development of such equipment, and should find it to their ultimate advantage to co-operate with equipment manufacturers to the fullest possible extent, offering them suitable opportunity, under proper supervision and protection, to try out their equipment and demonstrate its merits or shortcomings.

That the task of reducing present tie renewal costs on most roads is not beyond the realm of reality has already been demonstrated on a number of roads, through both reorganizations in forces and the use of recently developed mechanical aids. In fact, through a revision in its methods, one road in its 1939 renewal program, employing sizable specialized gangs and a number of units of one type of machine, effected a saving in renewal costs of more than 10 cents a tie over former section-gang methods. With such possibilities before them which, in the aggregate, would amount to savings of many thousands of dollars on any railroad, those roads that have given little consideration to their methods of making tie renewals in recent years can little afford to continue such methods without a careful investigation of recent developments in organization and mechanical equipment.





A Replica of 1830 Track Construction on the Baltimore & Ohio, Employing Wood Stringers and Sleepers and Iron Strap Rails

Rail—Its Importance in Transportation

This year marks the seventy-fifth anniversary of the rolling of the first steel rail in the United States. In commemoration of this event, *Railway Engineering and Maintenance* has prepared a series of articles directing attention to the importance of rail in transportation; showing how rail sections were developed; describing metallurgical and manufacturing progress; pointing out the importance of rail fastenings; illustrating the care that is given today in laying and maintenance to conserve the life of rail; and discussing the probable trend in shape, size, weight, length and metallurgical progress in the predictable future

IT is a far cry from the first revenue train, which was preceded by a man on horseback, to the modern streamliner running at 100 or more miles an hour. It is an equally far cry from the rail over which that first train ran to the rail of today which makes the streamliner possible. Rail has always been an essential element of railway construction. When Jessop placed single flanges on car wheels he gave it a place of importance which it has held without challenge for more than 150 years, with every prospect that it will continue indefinitely to be the foundation of transportation and transportation progress wherever mass movement of goods is required.

Modern rail is a high-class engineering material, the real development of which began on May 24, 1865, when the first steel rails rolled in the United States were produced at Capt. E. B. Ward's Chicago Rolling Mill, one of the predecessor companies of the United States Steel Corporation. The superior quality of the steel from which modern rails are made is the result of unceasing and intensive research on the part of railway engineers and rail manufacturers, directed toward better metallurgical control and improved manufacturing processes, together with more complete inspection of every step in these processes. The story of rail and the many phases of its development is told in the six articles that follow.

WHILE progress in land transportation depended on the invention of the wheel, rail has played an equally important part in the field of transportation during the last century. A study of the steps that have brought our transportation facilities to the present stage of perfection will show that every one was taken in answer to a demand for better transportation or in preparation for a larger operation. In any consideration of the importance of rail, it should not be overlooked that while the wheel had been in use for untold centuries, better transportation did not become a reality until it was supported on the rail.

We may say that modern railway transportation could not have been developed without the steam engine, and this is admitted freely. Yet no serious effort has ever been made to apply the steam engine to land transportation except in the form of the locomotive, and locomotives must of necessity run on rails.

Rivals of the Rail

Efforts have been made to substitute water carriage for rail carriage, by means of vessels on canals, streams and lakes, but there are several limitations to this form of transportation that have kept its popularity down despite low rates (not cheap rates) and have turned much of the potentially water-borne traffic back to the rails. These include lack of capacity to carry more than a small part of the traffic that must be moved; inability to reach more than a relatively small number of the communities that must be served; and the slowness with which the traffic moves.

Likewise, efforts have been made to direct rail-borne traffic to the highways and, while this has met with more success, for every community can be served by the motor truck, all of the highways so far built do not possess sufficient capacity to move the volume of traffic that the railways handle daily. The inadequacy of this form of transportation is shown by a study made recently by one railway that developed the fact that not less than

The Foundation of Railway Progress

152-Lb. Rail on the Bessemer & Lake Erie, With Sturdy Tie Plates and Fastenings, Represents the Heaviest in Track Construction Today

20,000 motor trucks would be required in continuous operation to handle the volume of business that this railway was then handling between two points about 400 miles apart. This estimate was made when the traffic on this road was well below normal, and it involved only a small part of its line.

How Are Rails Important?

These comparisons could be continued, but they demonstrate that the volume of traffic that must be moved in this country is so great that it can be handled successfully only by some form of mass transportation. No form of vehicle that uses the highways can compete in size with cars that operate on rails, whether they be for the carriage of goods or of persons. Cars can also be combined into trains containing up to 100 or 125 cars, while highway vehicles must operate as independent units.

One of the demands that have been made on transportation agencies since time immemorial is that goods and persons shall be moved expeditiously, which in the modern viewpoint means at high speed. No highway vehicle or water-borne vessel can ever approach the speed with which passenger and freight trains can be and are operated normally, although for short distances the former is able to make deliveries as quickly or sometimes more quickly than the railways.

Mass transportation is a prime necessity in this country. No form of transportation is able to handle so great a volume of traffic as the railways or handle mass transportation so expeditiously. The reason for this is that only vehicles that are supported on rails can be loaded so heavily; and no other type of vehicles can be moved at the speed or with the continuity of rail-borne cars. Therefore, regardless of what other factors are involved, rail holds a place of highest importance in transportation, and without it the transportation needs of the country could not be met.

Four Significant Events

There have been four significant events, the omission of any one of which would have prevented the development of railway transportation as we know it today. Other events have occurred to further railway transportation, some of which must be rated as of high importance, but none of these has exerted an essential influence on the character of or the way in which this development has taken place. In other words, they have not given direction to these developments; and their omission would not have stopped them.

Obviously, the first of these four essential events was the invention of the wheel, which took place before the dawn of recorded history. Prior to this, man had depended for his transportation on pack animals, the camel and the ass. There is some evidence that at first the idea of transporting goods was not associated with the wheel, for the earliest examples, found in prehistoric graves, have been chariot wheels. The horse and the chariot were first used for the haulage of persons. When the wheel was applied to the handling of goods, the ox became a factor in the movement toward mass transportation.

There was little further advance, except that chariots gave way to carriages and improvements were made in the construction of carts, until the beginning of the seventeenth century. At that time the miserable condition of the English highways and the insistent demand for a cheaper way to haul more coal from pit head to shipside resulted in the laying of longitudinal timbers to supprt the waggons, a new type of haulage vehicle distinct from the wain or wayne, which was used for highway transportation. The waggons were moved along the track on rowlets — small-diameter, wide-tread wheels resembling rollers. While this was, in itself, an important event, it was an adaptation of a previous practice of laying down planks to permit loaded vehicles to negotiate passage over soft spots or muddy roads.

Wheel Diameter Reduced

While the story of the development of rail is told in a following article, it will be well to emphasize at this point the effect of this development on the wheel and the interrelation of the wheel and the rail. It was only with difficulty that the rowlets were induced to follow the supporting stringers and derailments were common. When flanged cast-iron plates came into use for protecting these timbers, the wide rollers gave way to the wheel with its narrower tread. The diameter was much reduced, however, compared with the high wheels on the waynes, but the out-to-out measurement, 5 ft., was retained. Next came the edge rail and grooved tires, followed only a short time later by the

flat-top rail upon which similar wheels, but with flat treads and double flanges, were operated.

Jessop Takes Next Step

William Jessop, an engineer, constructed a railway at Loughborough, Liecestershire, in 1789. Jessop was familiar with the flanged plates and knew that derailments were common because the plate became covered with dirt and debris so that the wheels climbed over the flanges easily. He was also familiar with the double-flanged wheels and knew the complications that they introduced at turnouts. He decided therefore, to use flat-top, edge rails and to cast a single flange on his wheels. This was the second significant event in transportation, since it is the one that made our modern railways possible and thus raised rail to a position of high importance in land transportation. Incidentally, it also established the gage which is now employed as standard on all trunk line roads, for the wheels were 5 ft. out to out, and the head of his rails was 1¾ in. wide making his gage 4 ft. 8½ in.

Locomotives, Such as This One, First Used on the Great Northern in 1861, Are a Far Cry From the Giants of the Rails Today

Centuries had intervened between the invention of the wheel and the birth of the idea of placing a flange on it to guide it in its course. The next significant step in rail transportation, the third, and the one that settled for all time any doubt about the importance of rail in transportation, was taken only 31 years later when the first rail was rolled. The significance of this event lies in the fact that it made mass production of rail possible and thus opened the way for the remarkable expansion of railway transportation that occurred during the next century, and which could not have occurred otherwise.

Up to 1811 all rail had been made of cast or malleable cast iron, but the wheel loads were increasing to such an extent that some means of arresting rail breakage became necessary, and in that year wrought-iron rails were introduced to do this. Both the casting and the forging processes were so slow, however, that any considerable increase in the demand for rails would have swamped the manufacturing facilities of the day. Rails were then three to five feet long, while the first rolled rail was 15 ft. long. As an indication of the increased production made possible by the rolling mill, it has been stated that one set of rolls was able to produce as much rail in a day as had been produced by casting in a month, and certainly forging was no more rapid a process.

Rolling Mill Opens Way

While the rolling mill opened the way for a wide expansion of the railways, it was wrought iron that established the position of rail in transportation, for it enabled the roads to haul more goods in a single vehicle, more vehicles in a train and at faster speeds than had ever before been possible. It was unable to maintain this position of pre-eminence for the rail, however, because inherent characteristics of the metal limited progress in increased wheel loads and speed.

As has happened so often in the history of human progress, however, no sooner had the point been reached where progress was being affected by the limitations of rail, than another event occurred that opened the way for still greater progress and accomplishments in the field of transportation. Up to this time two methods of making steel were in vogue, and no others were known. Both were slow and tedious and incapable of being put on a mass-production basis. For this reason, as well as because other demands for steel were absorbing the entire output, no attempt was made to utilize steel for rail manufacture. It was only after Bessemer had perfected his process for making steel that this metal became available in sufficient quantity to permit its application to rail manufacture.

Fourth Step Taken

While Bessemer's process speeded up steel production and thus opened the way for large-scale manufacture of rail, the fourth of the significant events that were mentioned in the beginning occurred on May 24, 1865, when the first steel rail was rolled in the United States at the Chicago Rolling Mill, now a part of the United States Steel Corporation. This date has been chosen in the belief that it has had a more significant effect on

Today the Rail Has Caught up with the Locomotive and Made Possible the Powerful High-Speed Units Employed in Modern Train Operation

transportation than any other of those that compete with it for this honor, although steel rails had been used somewhat sporadically in England, Austria and Germany for several years prior to this date.

As has been mentioned, iron rail had reached the limit of its ability to support increased loads or allow greater speeds. The substitution of steel as a material for rail manufacture opened an era of progressive increases in both wheel loadings and speeds that has persisted for 75 years and no one can yet see the end. The expansion of the railways into every section of the country has been phenomenal. It would have been impossible if it had not been for the production of steel rails in quantities sufficient to meet the large demands that have been made on the steel mills for both new construction and maintenance throughout these 75 years.

How Sections Developed

Beginning as a longitudinal wooden stringer to carry coal waggons (cars) mounted on wooden rowlets (rollers) between the collieries and the staythes (wharfs), more than 100 years elapsed before anyone thought of using iron rails to support the wheels. During the next century the development was much more rapid, passing from cast iron through malleable and wrought iron to steel, and from cast and hammered sections to rolled sections. During this long interval literally a multitude of sections were designed and tried out in service, until today rail design has reached a measurable degree of simplification, although the ultimate in design may still be far in the future

NO element of the fixed property of the railways has passed through so many stages of development, with respect to both design and materials, as the rail. Beginning with wood, cast iron, malleable iron, wrought iron and steel have all been used, either alone or in combination, as materials for rails. Likewise, although the designs of rail have followed a relatively few basic patterns, almost countless variations of these basic designs have been recorded, a surprisingly large number of which are still in service.

While it is impossible to trace with certainty either the date or the manner in which the earliest prototypes of the present design of railway track were devised, all authorities agree that the first distinctively developed railways were employed at various points in England, particularly in the vicinity of Newcastle-upon-Tyne, for the transportation of coal from the collieries to shipside. While no definite dates can be assigned, evidence indicates that the initial development occurred between 1600 and 1650.

In describing a visit paid by his brother, Lord Guilford, to Newcastle-upon-Tyne, in 1678, Roger North mentioned that among the curiosities of the place were "way leaves" or land leased for laying wooden roads "to lead coals over the ground." Continuing, he said that, "the manner of carriage is by laying rails of timber from the colliery down to the river, exactly straight and parallel, and bulky carts are made with four rowlets fitting these rails, whereby the carriage is so easy that one horse will draw four or five chaldrons of coals and is of immense benefit to the coal merchants." A Newcastle chaldron contained 72 Winchester bushels. This description would indicate that these industrial railways were well established in that early day.

Early Track Described

The earliest detailed description of a railway track occurs in Jaa's Voyages Metallurgiques, Vol. 1, p. 199, published in 1765, in which it is recorded that "there are afterwards arranged along the whole breadth of this excavation pieces of oak wood, of the thickness of four, five, six and even eight inches square; these are placed across and at the distance of two or three feet from each other; these pieces need only to be squared at their extremities; and upon these are fixed other pieces of wood, well squared and sawed, of about six or seven inches breadth by five in depth, with pegs of wood, these pieces are placed on each side of the road along its whole length; they are commonly placed at four feet distance from each other, which forms the interior breadth of the road."

The unprotected timber caused much waste because it wore rapidly and renewals were required at short intervals. Yet for considerably more than 100 years no one seems to have thought of using iron either to protect the wooden rails or as a substitute for them; in fact, this idea was born of a financial depression. About 1767, the price of iron had fallen and there was so little demand for it that a shut-down of the furnaces was imminent. To prevent this, one company, the Colebrook Dale Works, in Shropshire, determined to cast plates to be laid on the upper surfaces of the rails. The idea was that the plates would not only prevent wear and abrasion of the timbers, but would diminish resistance to the progress of the wheels. The record adds that it was also considered that the iron could be taken up and sold in the event of a sudden rise in price.

Track Construction on the Camden and South Amboy Railroad (Now a Part of the Pennsylvania) When Built in 1831

First Rail Designed

The books of this company show that on November 13, 1767, between five and six tons of these rails were cast, and the record indicates that the experiment was so successful that the plates were not taken up as had been expected, and that iron rails were adopted gradually but generally in this district. Shortly after the Colebrook Dale experiment, cast iron rails having first one, then two, upright flanges were used at Sheffield, and with this invention it may be said that the de-

velopment of rail had begun. The next step was the edge rail, a term applied to several designs because the wheel ran on an edge or flange instead of on a flat surface. The first of these, which appeared among the slate quarries of Carmarthenshire, Wales, in 1770, was between four and five feet long and was oval in section. The tires of the wheels, which up to this time had been flat, were made of cast iron and were grooved somewhat like the modern pulley. This design was not very satisfactory, because the grooves became deepened by wear and thus created so much friction that it became necessary to lighten the loads.

To eliminate this trouble, the running surface of the rail and the tread of the wheels were made flat, but retained the double flange on the wheels, after which it is recorded that two horses could draw a train weighing 24 tons with ease, and that a single team could handle a volume of traffic in a day that would have required 400 horses if hauled by highway.

Organic Change Occurs

It should be borne in mind that during the quarter century subsequent to 1767, men all over England were engaged in designing rails, many of which never got into the record, and of those that did, only those can be mentioned which maintained the continuity of the development that was being carried forward and that influenced the designs with which we are familiar today.

An organic change in rail design and the second great event in land transportation occurred in 1789, when William Jessop decided to abandon the flat tires and flanged rails and reverse the arrangement by using flat-top rails and wheels with a single flange cast on the tire. Jessop's railway at Loughborough, Leicestershire, was laid with cast-iron fishbelly bars 3 to 4 ft. long, with a web ½ in. to ¾ in. thick, swelling out at the head to 2 or 2½ in.

There is little to record during the next two decades, although continuing efforts to improve rails with the purpose of giving them greater load-bearing capacity resulted in the use of malleable-iron rails at the Walbottle colliery in 1808. In connection with these rails, wrought-iron wheels having contours resembling those of today, were first used.

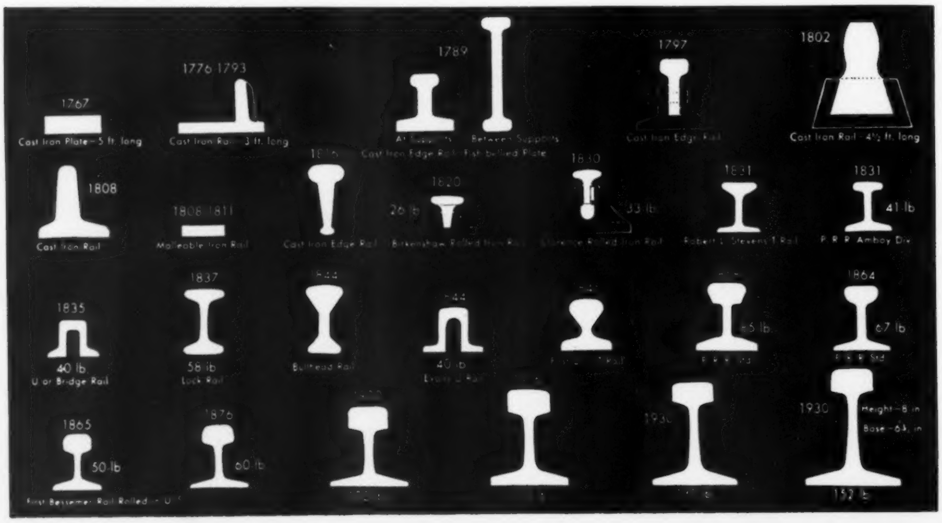
Events moved swiftly after this, for in 1811 wrought-iron rails came into use and apparently solved the problem of breakage as we hear little more about it for a number of years. It was not until 1820, however, that the third significant event in land transportation occurred, for in that year the first rail was rolled at the Bedlington Iron Works, after a design by Birkinshaw. These rails were 15 ft. long and the section was known as the T-section because it had a wide deep head and a web, but no base. Because of its peculiar shape, it required a chair at every sleeper or crosstie. While this was a long step in advance, the rolled rail did not at once supersede the older designs, for when the Stockton & Darlington, the first common carrier railway, was opened in 1825, it was laid with fishbelly rail weighing 28 lb. to the yard and having end supports at intervals of 3 ft.

Turn to America

Our interest now turns to America where the earliest railways followed the older English practice of using longitudinal timbers, with this difference that the wheels were flanged and the bearing surface of the timber was protected by means of an iron strap, a form of construction that persisted until 1847. Despite the widespread and long-continued use of longitudinal timbers with a strap-iron facing, iron rails were preferred, but their use was restricted by their high cost, since they had to be imported from England.

In 1830, Robert L. Stevens, president and chief engineer of the Camden & Amboy Railroad and Transportation Company, now part of the Pennsylvania, went to Europe to purchase a locomotive, later known as the John Bull, and rail for the road which was then under construction. Having much spare time on the sailing ship, he gave extended consideration to the section of the rail he was to buy. He was familiar with the Birkinshaw rail, the best-known and most satisfactory section then in use, but desired to get away from rail chairs, because of the scarcity of iron workers in the United States. He hit on the idea of adding a flat base which had the advantage of being able to support the rail in either the unloaded or loaded condition.

He whittled a model of this rail out of a block of wood and presented it and a drawing to a number of British manufacturers from whom he requested proposals, but not one of them submitted a bid. He finally induced the Dowlais Iron Works, Cardiff, Wales, whose owner was a friend of his, to roll the rail, but only after he had deposited a sufficient sum to cover any damage, because the workmen were in considerable doubt whether the mill could stand the strain of the rolling. As a matter of fact, the mill did break down several times and the first rails came out "twisted and crooked as snakes," until someone hit on a method of straightening them while still hot. The rolling was successful, however, for in May, 1831, the first consignment, 550 rails, arrived at Philadelphia. They were 16



How Rail Sections Developed, Shown in Chronological Order, from Flat Cast Iron Plates to the Modern 131 and 152-lb. Steel Rails of Today

ft. long and 3½ in. high; the head was 2⅛ in. wide and the base was 3½ in. These rails weighed 36 lb. to the yard, but subsequent rollings were increased to 39⅓ lb. and later to 42 lb. Stevens' drawing, which was submitted to the British manufacturers, showed the base increased in width at intervals of two feet over the ties, but this was finally discarded as being impracticable from a rolling standpoint, and the base was made of uniform width.

First Rail Rolled

Following the installation of Stevens' T-rail, for the name was transferred from the Birkinshaw rail to his section, a great variety of other sections were developed, some of which were only variations of Stevens' design while others departed widely from it. One of the latter deserves special mention, partly because of its peculiar design which resembles no other section, partly because it seems to have enjoyed relatively wide popularity, but primarily because it was the first rail rolled in the United States. This rail, which was U-shaped and weighed 42 lb. to the yard, a heavy rail for its day, was rolled at the Mt. Savage Iron Works, near Frostburg, Allegheny County, Md., in 1844. This rail, known as the Evans U-rail, was laid on a longitudinal sill, to which it was fastened by an iron wedge that was keyed under the sill, thus dispensing with outside fastenings. In that year, about 500 tons of this rail was laid on what is now part of the Baltimore & Ohio between Mt. Savage and Cumberland. Later this fastening gave way to driven spikes, an illustration of which is shown.

In 1845, the Montour Rolling Mill was built at Danville, Pa., expressly to roll rails, and it was at this mill that, in October, 1845, the first T-rails were rolled in the United States. During the next four years the facilities for rolling rails grew rapidly to meet the increasing demand created by the rapid expansion of railway mileage, which at the end of 1848 had reached a total of 6,261 miles, and in the latter year 10 mills were engaged in rolling rails. From 1848 to 1862, inclusive, the new mileage completed ranged from 1,016 to 3,442 annually, and the rolling mills were hard pressed to meet the demand thus created.

It may seem strange that the T-rail section did not become popular until after 1845, but this is explained by the fact that it was difficult to obtain, since it was necessary to import it, and it was too expensive for its use to be economically feasible on those roads that were only a jump or two ahead of the sheriff from the time of their inception, a classification that included practically all roads of the period, and many of those of later times. As soon as it was possible to do the rolling in this country, prices were reduced materially so that this section quickly became available to all roads and its use spread rapidly.

A Pictorial Record of the Various Rail Sections That Have Been Used on the Lines Making Up the Southern Railway System

Rail Length Increases

An interesting phase of early rail manufacture is the gradual increase in the length of rails. The first cast rails were 3 ft. long. This was increased to 6 ft. with the introduction of malleable rail. The records are not clear as to the length of the forged wrought-iron rails that were used between 1808 and 1820, but it seems probable that they followed the cast-iron with respect to length and shape. The first rolled rail was 15-ft. long but prior to 1850 there is no record of a greater length than 18 ft., while 15 ft. was more common. The first 30-ft. rail was rolled in the United States in 1855, but there was no current demand for rails of this length, and while the length increased gradually, this length was not exceeded, except for special rollings for experimental purposes, for 44 years, until the length was increased to 33 ft. in 1899.

One of the outstanding features of the rail of the period was the light sections that were in common use. Few rails exceeded 50 lb. to the yard, even as late as 1865, although there was a slow increase after that date, and the majority ranged from 40 to 45 lb., with many sections weighing less and a few weighing 47 and 49 lb. Railway mileage was increasing rapidly during this period and larger sections meant a larger outlay for track construction, a thing many companies could ill afford. It will also be noted by reference to the illustrations that many of the sections used from 1845 to 1854 were pear shaped rather than T-shaped. The reason for this lay in the difficulties that the mills experienced in rolling the T-section until the trouble was overcome in the latter year. From that time, the sections assumed more nearly the general shape of modern rail sections.

First Steel Rail Rolled

The fourth important advance in land transportation occurred on May 24, 1865, when the first steel rail to be rolled in the United States was manufactured in Captain E. B. Ward's Chicago Rolling Mill (now part of the United States Steel Corporation). This date is given preference, partly because of its great historic significance for the American railways and the steel industry, and also because, while steel rails were rolled in England in 1856, they did not prove satisfactory and the manufacture was discontinued, although it was again tried in 1863 and some rails were imported. The ingots from which these rails were rolled had been cast at Wyandotte, Mich., of steel made by the Kelly process, an American invention that conflicted with the Bessemer patent.

Immediate recognition was accorded the new material and from the first, steel rails began to displace iron rails. The rapidity with which this oc-

curred is shown by the fact that while the first commercial order was not rolled until August, 1867, and steel rails first appeared in the commodity-market reports in 1868, iron rail disappeared from these reports in 1882.

Rail Sections Small

Probably no feature of the early rail is more arresting to the maintenance officer of today than the small size of the sections. As has been mentioned, Stevens' first design weighed 36 lb., and although this was gradually increased, the increase occurred in several increments and ultimately amounted to only a few pounds. For many years the weight of rail was restricted by its high cost and the compulsion every construction engineer was under to obtain the largest mileage from a given expenditure. Largely for these reasons, although locomotives and cars increased steadily in size and weight, rail did not keep pace and gave quite unsatisfactory results.

The first steel rail rolled by Captain Ward weighed 50 lb., a relatively heavy section for the time, for many subsequent sections were considerably lighter; in fact, the first steel rail laid on the Southern weighed only 25 lb., while other roads used sections up to 40 and 45 lb. Captain Ward's rail resembled modern sections of rail more nearly than it did the iron rail of the period, but for some years it seemed difficult to get away from the characteristic design of the iron rail.

Early Sections Were Low

Following the precedent of iron-rail design, the early sections for steel rails were low with thick bases and thin heads. These light sections did not distribute the wheel loads, but apparently it did not occur to the engineers of the time that increased stiffness was necessary to do so, and it required almost 40 years to convince them that this was so, despite the fact that Wellington pointed it out in his epochal work on economics of railway location. In fact, at a meeting called in 1874 to consider rail design, the best that more than a dozen eminent engineers of that day could suggest was to transfer metal from the base of the rail to the head, the net result being an increase of 1/4 in. in the height of the rail and a negligible amount in stiffness.

Furthermore, this change which, by reason of the standing of the engineers who recommended it, carried the stamp of authority, created a problem with respect to rail breakage that became a curse to railway operation and maintenance, that persisted for more than three decades until the A.R.A. sections, in 1908, restored the metal that had thus been removed from the base. Again, lack of stiffness and the consequent failure of the rail to distribute the wheel loads increased the difficulties of maintaining line and surface, while the thin base and the concentration of wheel loads on individual ties destroyed a vast number of ties before their normal life had been attained.

Despite the multitude of new designs that were being turned out in an effort to improve rail performance, there was no appreciable improvement for, with a single exception that will be mentioned later, even the heavier sections were afflicted with the same disabilities as the lighter ones. The situation finally became so serious and seemed so nearly incapable of solution by the railways that in 1887 the Roadmasters' Association requested the American Society of Civil Engineers to investigate the whole subject of rail design.

A New Principle Applied

Two years before this, in 1885, the society had appointed a committee to study the proper relation between the rail head and car wheel, and the request was referred to this committee, which was reorganized and enlarged in 1890 to facilitate its study. In 1893, it presented a report which included a series of sections from 40 to 100 lb., increasing in increments of 5 lb., characterized by thin bases, relatively deep heads and moderate height.

Going back for a moment, in 1883, Dr. P. H. Dudley, consulting engineer, New York Central & Hudson River, had designed an 80-lb. section which differed sharply from the typical section of that day in that it was higher and had a thin head and thick base. Although a considerable tonnage of this section had been rolled and had been installed on several roads for several years prior to the completion of the A.S.C.E. designs and although it had demonstrated a marked superiority over other sections then in use, the A.S.C.E. committee ignored these facts in developing its designs. However, these sections were hailed as the cure for all rail troubles and within a remarkably short time accounted for more than two-thirds of the rail production of the country.

New Sections a Failure

As might have been expected, owing to the wide adoption of the A.S. C.E. sections, the number of new designs decreased sharply and relatively few were brought out until about 1907. In general, in accepting the A.S.C.E. sections the railways also adopted heavier rail, so that for several years, by comparison with the older sections, the new rail appeared to be more than satisfactory. Beginning about 1900, however, rail breakage again came into prominence and reports were rife that the rail was wearing with a rapidity until then unknown.

This situation resulted in widespread agitation for a better design, which culminated in 1906 in the appointment of a committee by the American Railway Association to restudy the whole subject of rail design. The committee made its report in October, 1907, in which it presented two series of rail sections, designated as A and B, increasing in increments of 10 lb. from 60 to 100 lb. The A series represented a modification of the Dudley section and the B series a modification of the A.S C.E. sections. Obviously, the two series represented a compromise between two widely divergent viewpoints regarding rail design.

One of the defects of the B series, which was designed primarily for roads having considerable curvature, was its lack of stiffness, while the A rail showed little improvement with respect to wear over the A.S.C.E. sections. Because these sections did not prove satisfactory, new designs again appeared in great numbers, but few of them demonstrated superiority over the sections then in use. The A.R.A. then turned the subject of rail design over to the American Railway Engineering Association.

A.R.E.A. Sections Adopted

After seven years of intensive study, this association adopted, in 1915, two sections weighing 110 and 120 lb. respectively. After five more years, two additional sections weighing 130 and 140 lb. were adopted in 1920. Continuing its investigation for four more years, the Rail committee of the Association developed a section weighing 150 lb., which was adopted in 1924. These sections again represented a compromise between the proponents of the high rail with a shallow head and of deep heads which obviously reduced stiffness, and did not prove satisfactory, partly because of the latter characteristic and partly by reason of the poor wearing qualities of the head.

As these defects were demonstrated in service, the Rail committee again undertook a study of rail design, concentrating attention on the 110 and 130-lb. sections. It concluded that a more economical distribution of the metal was possible, which would also result in increased stiffness as well as better wearing qualities. In developing these designs the committee endeav-

ored to obtain maximum vertical and horizontal stiffness for the amount of metal in the section; to proportion the base to height to insure stability against overturning; and to distribute the metal between the head, web and base in such a way as to minimize internal strains while cooling. That these objectives have been attained in large measure through this more scientific approach is indicated by the fact that since these sections were adopted in 1933 substantially all rail heavier than 100 lb. has been either the 112 or the 131-lb. section which resulted from the committee's study.

Length has been closely allied with the development of the section of rail. The first rails were from three to five feet long. The first rail to be rolled, in 1820, was made 15 ft. long, and rail lengths ranged from 15 to 18 ft. during the next 30 years, after which they increased slowly to about 28 ft., this limit being set by the equipment available for hauling them. The next increment was to 30 ft., and in 1898 equipment became available to make possible an increase to 33 ft., which became the universal length until cars in which 39-ft. rails could be hauled came into use generally about 15 years ago, and this length was adopted.

In an effort to eliminate joints, several roads have experimented with still longer rails, ranging from a mile to 6,900 ft. in length, produced by butt welding standard length rails into a single long rail. In another test, some experimental rail 78 ft. long has been laid. Both the welded rail and the 78-ft. rails are under observation, and are being watched with interest, not only by the appropriate committees of the A.R.E.A. but by maintenance engineers generally, many of whom believe that longer rails will demonstrate sufficient advantage to warrant their adoption.

Thus the history of the development of rail, which is told here in only the barest outline, like that of all human endeavor, is replete with incidents of success and failure, of advance and retreat, of confusion and orderly thinking, but through it all there has been a continuous movement toward the goal of design that will give the performance of maximum value. It is a tale of romantic interest.

Metallurgy and Manufacture

If one were to compare the first cast-iron rail, the first wrought-iron rail or the first steel rail with a rail of today, he would probably have difficulty in visualizing how the modern rail grew out of these early materials. The development was slow, but generally kept pace with the advances that were made in the processes and technic of making iron and steel. The extent to which modern rail is a product of and has been perfected through the science of metallurgy is shown in this article

NO matter how nearly perfect the shape and size of the section may be the performance of rail cannot be expected to be satisfactory unless the metal possesses physical properties that will enable it to support the traffic loads that are imposed upon it and to withstand the abuse to which all rail is subjected. It is of no less importance that the quality of the metal from which the rail is made shall be uniform. These physical properties depend so largely upon the chemistry of the steel and the processes of manufacture that is has been said that metallurgy is the most important element in the foundation of modern transportation. Uniformity of quality can be obtained only through close control of both the chemistry of the metal and the process of manufacture.

In the process of its development, rail has passed through many phases, in large measure paralleling advances in the processes and technic of making iron and steel. The first rails were of cast iron, which differs chemically from steel in that it contains less iron and more of other elements, including carbon, silicon, phosphorus and, in some cases, sulphur and manganese. Physically, it contrasts with steel by reason of its weakness or low resistance to stress and impact, its lack of ductility and its complete absence of malleability, characteristics that make it entirely unsuited for rails.

Only a slight advance was recorded in the use of malleable cast iron, which in its day was hailed as an improvement of great importance. Roughly speaking, and ignoring certain technical details of manufacture, this material is merely cast iron that has been annealed. In its physical properties it stands between gray-iron and steel castings and possesses a small amount of ductility and malleability. It is considerably stronger than cast iron, but cannot be forged or wrought, and could not withstand the stresses set up by modern wheel loads; in fact, it failed under even the light loadings of its day.

An important advance was made when wrought iron was applied in the manufacture of rails, and it remained the sole material available for this purpose for approximately 50 years, until Bessemer completed his process for making steel and thus made possible mass production, one of the basic requirements of modern rail manufacture.

Not Until the Manufacture of Steel Was Put on a Large-Scale Commercial Basis, Was the Way Opened for the Rapid Expansion of the Railways.

Wrought iron is almost identical chemically with very low carbon steels, its principal distinction being that it is made by a process that finishes it in a pasty instead of a liquid form, and which leaves from one to two per cent of slag disseminated mechanically and quite uniformly throughout the mass. Wrought iron is soft and has a low elastic limit, compared with steel, so that it crushed easily as wheel loads were increased still further, and the metal shredded under slipping drivers.

In many respects wrought-iron

rails gave satisfactory service until wheel loads reached the level of 10,000 to 12,000 lb., after which broken rails and mashed heads became the outstanding problems of rail maintenance.

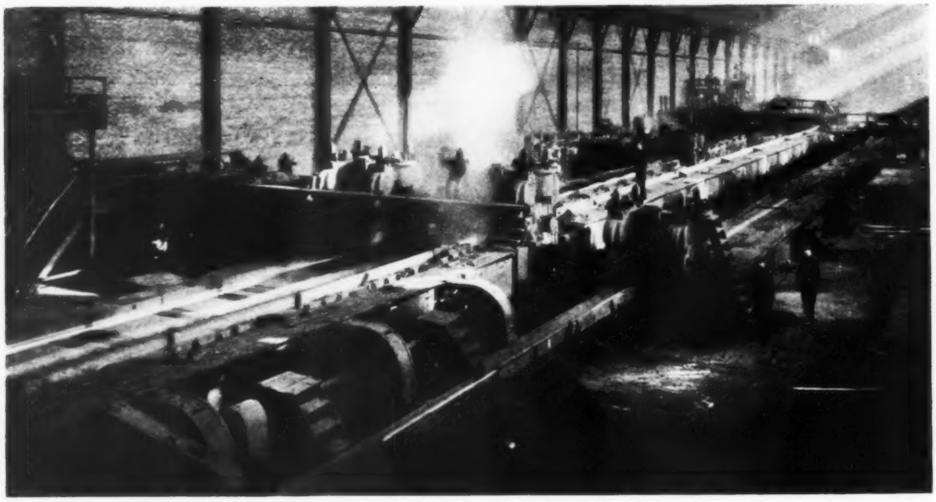
Steel Became Available

Steel had been made from very ancient times, but up to 1856 only two methods, the cementation and the crucible processes, were known, neither of which was adapted for mass production, an essential and insistent requirement in rail manufacture after about 1840. Because wrought iron will not respond to any hardening process, no improvement in rails became possible until Bessemer perfected his process, which he patented in 1855. The first steel rails were rolled in 1856, a considerable tonnage being placed in service in that year. For reasons that will be explained, they were so unsatisfactory that their manufacture was discontinued for several years.

Essentially, Bessemer's process consists of blowing air under pressure through a mass of molten metal, generally pig iron, contained in a vessel called a converter. As a result of this action, a portion of the iron, all of the silicon and manganese, and most of the carbon are oxidized, successively in the order named. The iron, silicon and manganese combine to form slag, while the carbon is consumed, wholly or in part, and passes off in the form of gas. After blowing, certain deoxidizers and recarburizers are added to give the metal the chemical composition and physical properties that are desired.

As it comes from the converter, the steel contains iron, carbon, manganese, phosphorous, sulphur and silicon, each of which contributes certain properties such as purity, hardness, ductility, increased strength, etc. The amount of each of these constituents contained in the steel must be controlled carefully, however, and balanced with each other, for too much or too little of any one or a distortion of the ratios between some of them will create undesirable physical properties in the finished rail.

In his earliest operations, Bessemer employed only Swedish iron, which was low in phosphorous and relatively high in manganese and produced an excellent steel. British manufacturers to whom he granted the right to use his process, employed English ores that were high in phosphorous and low in manganese, and thus failed to produce a satisfactory steel. In large part, this accounts for the failure of the first steel rails to give satisfaction, although there is a record of one of them that remained in service for 16 years.



The Modern Rolling Mill Has Made It Possible for the Manufacturer to Meet Railway Requirements for High-Grade Rail

Steel Rails Rolled Here

Eventually, in 1856, R. Mushet discovered that the addition of manganese in the form of spiegeleisen would overcome this trouble. As a result of their former experience, however, the manufacturers were so opposed to the process that they did not take advantage of Mushet's discovery, and Bessemer was forced to build his own plant, which he opened at Sheffield in 1860, and in which he again rolled rails in 1863, some of which were imported into the United States. It was not until May 24, 1865, that the first steel rails, six in number, were rolled in the United States, and it was more than two years later, in August, 1867, that the first commercial order was filled, but their use expanded rapidly from that time and iron rails were discontinued.

From the beginning, railway engineers appear to have left the chemistry and manufacturing processes almost wholly to the manufacturers, and most of the early specifications made no mention of chemistry, although some of them contained elaborate provisions relating to inspection and physical tests, apparently a result of their experiences with iron rails. Later specifications, issued between 1875 and 1880, attempted to control the carbon, setting the limits at 0.30 to 0.50 but were silent with respect to the remaining constituents. Still later, mention was made of phosphorous and then of silicon, and some of these specifications contained detailed requirements with respect to manufacture.

It should not be assumed that railway engineers took no interest in the subject, however, for the record is replete with papers and discussions with respect to both chemistry and manufacture. As time went on this interest was translated into action and the situation began to resemble that with respect to design, that is, a large number of railway engineers began to write complete specifications, doing this individually with no means for coordinating their efforts, save such advice as they were willing to accept from the steel companies. As a result, this phase of rail procurement was on the verge of chaos and rail quality remained unsatisfactory.

Roadmasters Take Hand

That the quality of the rails were not satisfactory was emphasized in a report that was presented to the Roadmasters Association in 1892, in which it was brought out that the variations in hardness and wearing qualities of the rail that was being furnished were causing much concern. This excel-

lent and comprehensive report recommended that the limits for carbon be fixed at 0.25 to 0.60 per cent and those for manganese at 0.60 to 1.60 per cent.

Included in the report was the observation that "carbon, manganese and silicon are quite under the control of the manufacturer, but phosphorous and sulphur exist in the ores and the fuel and are difficult to eliminate by the Bessemer process, so that the composition must conform to the limitations of phosphorous and the amount of carbon that is used. A general formula is not practicable, and it would be to the best interests of the railways to specify the requirements of their service and leave the chemical composition to the manufacturers," a view that was held quite widely.

Because the A. S. C. E. rail sections were still believed to be satisfactory at the time that the American Railway Engineering Association was organized, the subject of rail specifications, rather than design of section, was uppermost in the minds of its members and this was the first subject assigned to the Rail committee. At the annual convention in 1902, this committee submitted the rail specifications recommended by the American branch of the International Association for Testing Materials (afterwards the American Society for Testing Materials). The chemical properties were those of the Carnegie Steel Company, which, with a few modifications, remained the standard for Bessemer rail as long as it continued in use.

This was the first effort on the part of the railways to co-ordinate their requirements for rails. It was at this meeting that the first mention was made of the possibility of using open-hearth steel for rail manufacture. By this time engineering officers had awakened to the fact that the A. S. C. E. sections were far from satisfactory, but with this awakening came also the realization that it was equally important to do something with respect to the quality of the steel, and there developed a definite trend toward the use of open-hearth steel, which has greater density and toughness than the Bessemer steel that was used for the manufacture of rails. This steel is also distinguished from that made by the Bessemer process by the fact that it contains less manganese, phosphorous and sulphur.

Rail Causes Concern

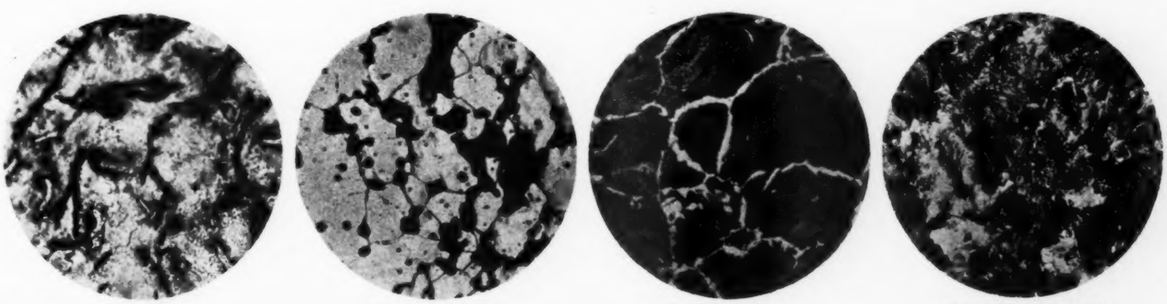
Partly by reason of its lower carbon content, as wheel loads increased, as they did rapidly shortly after the turn of the century, Bessemer rail demonstrated its inability to stand up under traffic, particularly with respect to head wear and flow of metal while broken rails increased alarmingly. The situation finally became so acute that all interests were stirred. The A. S. C. E. deemed it advisable not only to restudy its sections in the light of the widespread criticism they had aroused, but to include rail specifications as well. The A. S. T. M. continued its study of rail, and committees from these societies held joint meetings with the Rail committee in an effort to arrive at some solution of the problem.

Finally, the American Railway Association directed the committee that it had appointed to develop a satisfactory rail section also to prepare specifications for the manufacture of steel rails. The steel companies were asked to co-operate, and in addition, the committee employed several disinterested men of national reputation with respect to knowledge of steel manufacture and the properties of steel, to act as consultants. This committee made a final report on April 22, 1908, presenting specifications for both Bessemer and open-hearth rail, at the same time recommending that the whole subject of rail design and manufacture be turned over to the A. R. E. A. This recommendation was adopted, since which time the Rail committee of this association has studied these subjects constantly and has reported its findings annually.

Beginning in 1911 a new factor was introduced to disturb railway officers with the discovery that the open-hearth rails which had almost entirely displaced Bessemer rails, were afflicted with a dangerous defect that came to be known as the internal transverse fissure. Among the first discoveries, it was disclosed that certain heats were particularly subject to these fissures while others seemed to be entirely free from them. Almost immediately an intensive search was started to determine the cause, but without result.

Engineering officers insisted that they had their origin in improper manufacturing practices, while the manufacturers attributed them to excessive wheel loads and inadequate maintenance. Practically no progress was made until both the railways and the manufacturers agreed to pool interests and begin a joint investigation to determine the cause of the trouble. This investigation was started in 1931, in the field and at the Materials Testing laboratory at the University of Illinois. Definite information has since been adduced that transverse fissures have their origin in shattered areas in the steel. Various theories have been advanced to explain the presence of these shattered areas and their cause, but so far no positive proof of the real cause has been adduced.

Parallel with this search, several steel companies were undertaking independent research to discover ways whereby the difficulty could be eliminated, and controlled cooling resulted, the purpose of this process being to allow the metal to cool through the temperature range in which these shattered areas form at such a rate that they do not develop. Brunorizing was also developed out of this research, a process in which a special



Cast Iron Wrought Iron Bessemer Steel Open-Hearth Steel

Photomicrographs of the Four Basic Materials That at Different Periods Have Been Employed for Rails—Magnification 100X.

Left to Right—(1) Cast iron such as was used in the earliest cast iron rails. Note the graphite leaves or flakes. (2) Wrought iron of a 56-lb. rail rolled in 1868, which gave good service for those times. Note the slag and cinder inclusions. (3) Bessemer steel of a 75-lb. rail rolled in 1899, which gave good service under the conditions existing. Note the ferrite network of the lower carbon steel then used. (4) Open-hearth steel of a 112-lb rail rolled in 1937, which is giving good service. Note the uniform character of this eutectic steel.

thermal treatment accomplishes the same result and imparts to the rail improvements in physical properties.

Almost simultaneously with these developments, there have also been developed methods for heat treating the ends of rails to harden them and thus reduce the rate of rail-end batter, which has given trouble for years, but which has become far more acute under present-day wheel loads and train speeds. This treatment can be given either in the field or at the mill; in either event the principle of the process is basically the same, the rail end being quenched after reheating or from the hot-bed temperature from a temperature of approximately 1,500 to 1,600 deg.

Inspection Still Needed

Today, as in the past, inspection is one of the most important items connected with rail manufacture, for experience has shown that, despite the most careful control of the chemistry of the steel and of every step in the manufacturing process, certain defects will occur in the rail. Many of these are on the surface, being incidental to the tempo of rail manufacture, and can be corrected at the mill; some are more fundamental and require rejection of the rail. It requires long experience and expert knowledge of metallurgy to enable one to pass on rail defects, whether on or beneath the surface. For this reason, rail inspection has become so highly specialized that it is today recognized as a profession. No mention of rail inspection would be complete without reference to the part that Capt. Robert W. Hunt played in its development, and particularly of the complete inspection of rail that he initiated and that has since become standard practice for the majority of the rails rolled, which inspection covers every item in the process of manufacture from the open-hearth furnace to the loading of the rail. Captain Hunt entered the picture in the early days of the manufacture of rails from steel, and it was primarily through his efforts that rail inspection was put on the sound and comprehensive footing on which it stands today.

It is thus evident that behind the rail, as one sees it in service in the track, there is a long history of development and that it represents far more than is visible to casual observation. Like all developments, that of the metallurgy of rail took place slowly, sometimes in the wrong direction; often, when an improvement in quality became imperative, no way seemed open to further progress; almost as often, when success seemed to be imminent, failure intruded and a new start became necessary. Yet, we can see in retrospect that there was always progress.

Fastenings Show Marked Development

As soon as rail came into use to support the wheels of railway vehicles, certain accessories became necessary, which are today included in the general classification of rail fastenings. These include joint bars, bolts, spikes, tie plates and anticreepers. The development of these devices is discussed briefly in this article. Frogs and switches are also included because they combine with the rail and fastenings to form the superstructure of the track

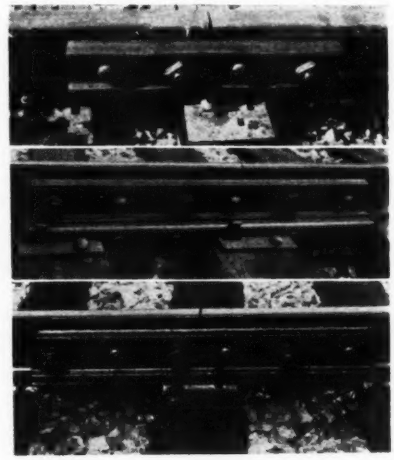
NO trackman would think of installing rail in track today without providing joint bars to insure correct alinement or register with the rails immediately adjacent, and making provision to hold it securely in place. This was not always so, however, for the early rails had no joint fastenings and the means provided for holding them down were highly ineffective.

The first metal support for the wheels consisted of flat cast-iron plates which afterwards had one or both edges turned up to keep the wheels from straying off the track. They required no joint fastenings, and were held on the supporting timber by large nails driven through countersunk holes. It was only when edge rails came into use that it became important to aline them carefully.

Rail Chair Appears

Because of the peculiar design of the end, splicing was not practicable, but as the derailments continued something had to be done and the rail chair made its appearance. Although the early forms of this device were crude they represented the first effort to provide a joint fastening and as such were a real advance. They were reasonably effective for the light rail and wheel loads of the day and were applied to the first rolled section which appeared in 1820, for this rail, having no base, could have been supported in no other way. As the rolled section was 15 ft. long, it required intermediate as well as end chairs.

Robert Stevens' design of rail was a deliberate attempt to avoid the use of rail chairs, and it became necessary for him to provide other fastenings. He did this by placing a lug on the web at one end of his rail, which he punched to fit a similar hole in the web of the adjacent rail, using a bolt to join them. He also devised a hook-headed spike for holding the rail in place, which does not differ essentially from the cut spikes in common use.



Modern Joint Assemblies, Designed to Develop the Strength and Continuity of the Rail Itself, Are in Striking Contrast with the Straps and Fish Plates of an Earlier Day

In the meantime, the use of edge rail, as it was still called, made little headway in the United States because the price was prohibitive. As a substitute, longitudinal timbers were employed, as in the earliest railways in England, but protected by flat iron bars, known as strap rail. The first of these was $\frac{1}{2}$ in. by 2 in., but as cars and locomotives increased in size the strap rail increased somewhat in width and to $1\frac{1}{4}$ or more inches in thickness. This rail, which continued in use to 1847, had no joint fastenings and was spiked to the timbers through countersunk holes.

These rails were responsible for many delays and even serious accidents. The passage of the wheels tended to loosen the spikes and cause the rails to curl up at the ends. They were called snake heads. In the beginning, it was customary for every train to carry a sledge and when a loosened rail was encountered the train was stopped and the spikes were driven down. This caused too many delays, for after repeated redriving, the spikes retained little of their holding power and it was not uncommon for the snakehead rails to cause derailments or to penetrate the floors of passenger cars and cause injuries and even fatalities to passengers.

Up to 1854, rail sections were pear shaped because this was the nearest approximation to the T-section that the American mills were able to roll. These sections did not lend themselves to the use of splice bars and the rail chair proved to be the most satisfactory fastening, and its use became a settled practice as long as iron rail continued in service. The first joint bars were merely flat iron straps called fish plates, this name being an adaptation of the nautical term used to designate the flat strips of iron or wood used for splicing masts and spars.

None of the early designs of rail allowed the fish plate to support the head. In 1874, Octave Chanute, then chief engineer of the Erie, conceived the idea that such support would improve the performance of the rail, and experimented to find the correct angle for the underside of the head. He determined that this should be not greater than 15 deg. with the horizontal, for at greater angles the fish plates were loosened by reason of stretch in the bolts. He adopted this angle, therefore, and made the base angle 12 deg. to avoid unnecessary metal in the flange. Prior to this time no joint fastening had been satisfactory and, while Mr. Chanute's development marks an important advance in the development of joint fastenings, it should not be assumed that it solved the joint problems that were plaguing the maintenance men of that day. In the first place, the rail section was too low to permit effective support from the joint bar, and in the second, no one seems to have been able to get a decent fit between the fishing surfaces.

Rail Creepage Acute

With the light loading and the low speeds of the early railways, rail creepage was not a problem, but as loads and speeds increased it became an acute one and the slotted angle bar was devised to provide anchorage for the rail. This remained the only form of rail anchorage available to combat rail creepage until anti-creepers came into use a little more than three decades ago. Since then the slotting of the angle bars has been discontinued gradually, until today few roads follow the practice, placing complete reliance in anti-creepers, or in the more recently developed fastenings which incorporate anti-creeper characteristics. More recently to get away from the twisting distortion created in the angle bar under modern wheel loads by reason of its unsymmetrical section, the use of symmetrical joint bars, commonly known as the toeless type, is increasing.

Equally Marked Development Has Taken Place in Frog and Switch Construction Since the Days of the Stub Switch

Obviously, the first track bolts were of wrought iron, and as such their strength was low and their ductility high, with the result that they stretched easily and could not be turned up very tight. Even after steel rail replaced iron rail, iron bolts continued in use and the low-carbon steel bolts that finally replaced them were not much better. While this was by no means the principal reason why the early joint bars did not perform satisfactorily, it was an important one that was not overcome until heat-treated bolts made their appearance about 30 years ago.

As has been mentioned, Robert L. Stevens devised the first track spike in his effort to avoid using rail chairs. The design has not changed fundamentally since 1830, although an untold number of variations of the basic design have been developed, only one or two of which have affected the utility of the spike. Only one alternate design, the screw spike, has been developed as a substitute for the cut spike and, while it has been used to some extent, it has not met with widespread favor. While spikes have passed through some metallurgical development, the range has been small, from wrought iron to low-carbon steel or, at most, only slightly above the low-carbon classification.

Tie Plates Develop Slowly

Except for the chairs with which early joint ties were fitted, no effort was made for many years to protect ties from rail cutting although this form of destruction accounted for a relatively large number of ties. With the advent of the thin-base rail sections that appeared about 1874, rail cutting became acute and, in addition to destroying ties, created a great amount of trouble from tipping rails, particularly on curves.

Almost immediately, the development of tie plates began. For some reason, early designers were a unit in their belief that these plates required substantial anchorage in the tie to prevent movement and thus eliminate distortion of the gage, which was then giving so much trouble. Unfortunately, while these tie plates served to hold the gage for a time they did more ultimate damage to the ties than would have occurred from rail cutting without them. With the advent of the treated tie neither of these forms of damage could be tolerated any longer, and preference swung to smooth or slightly corrugated bottoms.

Furthermore, the early tie plates were small in area, so that many of them cut into the tie almost as freely as the rail. Again, with one or two exceptions, the sections were thin and bent under the repeated wheel loads, thus adding to the destruction of the tie and increasing the difficulties of maintaining gage. With the advent of heavier rail sections during the last decade, and of the practice of using independent fastenings for the tie plates, and the wider use of canted plates, there has been an increasing use of smooth or lightly corrugated bottoms that do not cut the fibres of the wood, while both the area and the thickness of the plates have been increased materially. The first tie plates were without shoulders; the next step was an outside shoulder, which was found to be a marked improvement, and it was only a short time before the double-shoulder design came into use. This proved to be of such marked advantage that the use of double shoulder tie plates, of ample area to protect the tie and of sufficient strength to prevent bending, is standard on most roads today.

This discussion would be incom-

plete without some mention of the development of frogs and switches, for turnouts are a necessary part of the track structure. When flat plates were used for rails no special provision, so far as the rail was concerned, was needed to divert traffic from one track to another, but when edge rails came into use, some provision for such diversion did become necessary. The first switches were tongue switches, which were pivoted at the heel, with a point sliding back and forth on a plate or in a channel. While there were a number of variations of this type, the next step in the development of the modern switch was the stub switch, which made its appearance shortly after the rolling of rails was established. This design served for almost a half century, until the split switch was invented, and persisted for many years thereafter, for the split switch was introduced more slowly than almost any other track device. In fact, as late as 1887 it was brought out that many of the roadmasters attending the Roadmasters' Association that year had never seen a split switch, although it had been invented almost 20 years before the date of this convention.

Frogs were first made of cast iron and were satisfactory for a number of years. But as wheel loads and speeds were increased, the cast metal was unable to resist the impact of the wheels and the frogs broke with disturbing regularity. However, cast-iron frogs were in service until well after 1880. The difficulties that were being experienced stimulated much effort to develop a substitute or an alternate design, one of which was a rail about nine feet long, pivoted at the center and held down by a bolt passing through a plate set in the tie and keyed. The rail was then turned to line up with the track on which the movement was to be made.

While this device gave much trouble, it seems to have been used widely because of the desire to eliminate the cast-iron frog which was much given to breaking under the passage of trains, sometimes causing derailments. The next step in the development was the Lewis frog, which consisted of a solid cast steel cylinder set vertically in a frame, having a deeply grooved top to provide a flangeway. It could be turned so that the flangeway registered with the rails for either route.

Finally, with the advent of steel rails, the present type of frog was designed and, while the early examples of this design were a far cry from the modern open hearth and manganese steel frogs, they were fundamentally the same with respect to the basic idea of the design. The early frogs of this type gave so much trouble, largely by reason of poor workmanship, that it is a favorable commentary on the acumen and persistence of the maintenance officers of the period that they recognized the intrinsic merit of the design and persisted in the use of the frogs in the face of almost constant trouble with them.

Modern frogs and switches have few of the defects that characterized these track accessories less than three decades ago, for through co-operation of the Track committee of the A.R.E.A. and the manufacturers, new designs and better construction have replaced the inadequate designs of the former period. Through this co-operation the riveted frog has practically disappeared and the bolted all-rail frog is largely confined to tracks of light or moderate traffic, while solid manganese and the rail-bound manganese frogs are now in common use in the heavier traffic tracks of all important roads today. The high character of workmanship and manufacture also stand in strong contrast with that of the former period when there were few or no standards of design.

Making Good Rail Better

For many years much difficulty was experienced in the maintenance of rail, for as yet no means had been discovered of overcoming the effects of the destructive forces that are continually acting on rail. In recent years, however, the quality of the rail itself has been improved and practices have been developed that not only insure better performance currently, but which greatly extend the service life of the rail. Some of the conditions that existed in former years and the measures that have been taken to overcome them are discussed in this article

WITHIN the memory of men still actively engaged in track maintenance, every operation connected with the laying of rail and with its maintenance during its service life was performed by hand. Today, most of those involved in the laying of rail and many of those required in its maintenance are performed mechanically. This development provides a measure of the advance that has been made in the care that the rail now receives during its installation and its service.

Long after steel rails came into universal use, there were general and emphatic complaints from maintenance officers concerning the workmanship connected with the finishing of the rail, a common statement being that many of the rails were so crooked when received that they could not be used, while others could be made serviceable only by straightening them with a jim crow. Again, it was not uncommon for rails to be kinked severely when they were being unloaded preparatory to laying, for they were generally shoved off a flat car and allowed to fall to the ground.

Rail joints gave inadequate support to the rail ends, and bent or "dipped" joints were common. Bolts

The Use of Power Tools and Equipment To Lay and Service Rail Was an Important Step in Protecting It Against Damage and Premature Destruction

could not be kept tight and metal, fibre and iron-clad fibre washers were tried in turn, but all proved to be about equally ineffective. Finally, the spring washer appeared and was received with such favor that within 10 years one manufacturer advertised that 15,000,000 were in service.

Rail creepage was another serious problem, for, aside from the inade-

The Tie Adzing Machine, to Insure Even Bearing for the Rail; Welding, to Build Up and Harden Rail Ends; and the Power Wrench to Insure Uniformly Tight Joint Bolts, Have Added Materially to the Service Life of Rail

quate anchorage provided by the slotting of the angle bars, there was no means for holding the rail against longitudinal movement. It was difficult to maintain gage on tangents and almost impossible to do so on curves without using rail braces freely. Most of the cuts were either not drained or drainage was inadequate, and soft track was responsible for much damaged rail. When joint bars wore, as they did in a comparatively short time since they were generally of softer metal than the rail, the only recourse was to discard the old bars and apply new ones, a comparatively costly operation. The result was that worn bars were often retained in service, to the serious detriment of the rail.

More Care Used

No mill today sends out rails that are not straight, so that this problem that was once so troublesome has been eliminated. No maintenance officer today allows rails to be unloaded in such a way that there is risk of bending them. Instead of being dropped from cars in unloading, they are picked up by a crane and set work-way gently on the shoulder of the roadbed, care being exercised to insure that the rail is supported uniformly throughout its length to avoid the formation of permanent kinks. When the rail is installed, it is again picked up by a rail crane and placed in the track.

This is only the beginning of the care with which the laying of rail is now surrounded, for experience has shown that carelessness in laying invariably results in damage to the rail, while its life can be prolonged materially by the exercise of a few precautions; these precautions also reduce the effort required to maintain the rail.

The first of these measures is to insure a uniform bearing for the rail as it is placed in the track. To insure this bearing it was formerly the practice to adze the ties by hand in preparation to receive the new rail. With 25 to 30 men engaged in this operation and working under severe pressure, it was practically impossible to insure a uniform bearing, while the rail seats at the two ends of a tie were seldom in the same plane. Today, by means of adzing machines the ties are adzed smoothly to receive the tie plates, and no difficulty is involved in getting the two surfaces in the same plane.

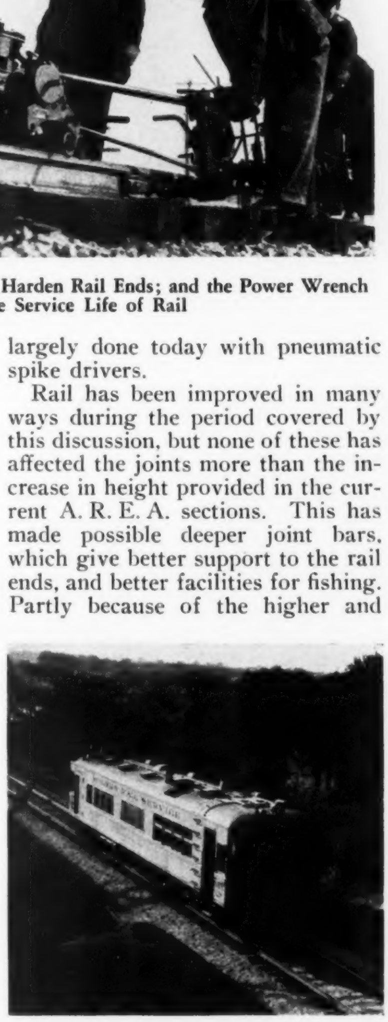
Tie Plates Are Needed

When rail bears directly on wooden crossties, relative movement between the tie and the rail occurs with the passage of every wheel. This sets up an abrasive action that almost invariably results in the outward tipping of the rail and distortion of the gage, which grows worse progressively. To prevent this abrasive action and thus prevent the damage that ensues from tipping rail or wide gage, modern practice in rail maintenance includes the use of double-shoulder tie plates of ample area and thickness, fastened independently to the ties.

Many ills besides those of buckling track follow in the wake of creeping rails, and rail creepage thus becomes a positive factor in determining the life of rail. Anti-creepers not only maintain a uniform expansion gap, and thus reduce the rate of rail-end batter and the tendency of the rail ends to chip, but they prevent damage to the rail joints which may occur with excessive expansion gaps.

Having laid the rail in place with the crane, the bolts are inserted in the joints and tightened with bolt tighteners, which are also used for stripping the old rail ahead of the laying, thereby insuring more uniform tension in the bolts than can be obtained with hand tightening. Likewise, the driving of the spikes is largely done today with pneumatic spike drivers.

Rail has been improved in many ways during the period covered by this discussion, but none of these has affected the joints more than the increase in height provided in the current A. R. E. A. sections. This has made possible deeper joint bars, which give better support to the rail ends, and better facilities for fishing. Partly because of the higher and



Scientific Rail Inspection With Flaw Detector Cars Has Greatly Reduced the Hazards of Internal Defects

stiffer rail sections and partly because of the better support afforded by the stronger joint bars, dipped rail ends no longer trouble the trackman to the extent that they did formerly. Again, instead of discarding worn bars, wear on the fishing surfaces is compensated for by the insertion of rail-joint shims between the bars and the under side of the rail head. When fishing wear has reached the point where the shims are no longer effective, numerous roads are now restoring the worn metal by reforming the bars or by welding and are then grinding the fishing surfaces of the bars to insure a fit.

Another important improvement that has had a marked influence in

bettering the performance of rail, is the heat treatment of track bolts. Heat-treated bolts do not stretch appreciably and take no permanent set under the tensions normally required for track bolts. For this reason, the desired tension can be maintained in the bolts over long periods. This factor and the heat treatment of the joint bars have tended to reduce the problems of fishing wear and loose bolts, to the very great benefit of the rail.

Until recently the section forces were expected to maintain the necessary tension in the track bolts. Within the last five or six years the practice of using power bolt tighteners in routine maintenance has been gaining in favor, because experience has shown that the joints can be maintained to a much higher standard and that power tightening is beneficial to the rail.

From the time open-hearth rails came into vogue, the railways have been faced with the transverse fissure. Efforts to find means of detecting the presence of these fissures during the process of their development culminated in the invention by E. A. Sperry of a device that not only detects transverse fissures, but other internal defects in rail as well. Since this method has been perfected, it has become the general practice to inspect rail with the detector car at relatively frequent intervals, and while the number of transverse fissures discovered has increased somewhat of late, the number that have made their presence known in service has decreased.

Few developments have done more to improve the performance of rail and increase its life in primary service than the heat treatment and welding of rail ends. As long as rail joints remain they will batter. Heat treatment hardens and toughens the metal and thus retards the rate at which batter occurs. However, when, despite the effects of heat treatment, rail-end batter has progressed to the point where it is affecting the riding qualities of the track and is creating excessive wear on the fishing surfaces, the rail ends are now being restored to their original section by welding and continued in service indefinitely, until other wear dictates the release of the rail.

Wear on tangents takes place slowly on the running surface of the rail. In addition to this vertical wear, the outer rail on curves is subject to relatively rapid abrasion from the wheel flanges, the rate of this wear depending on the degree of curvature. To reduce this wear, curve lubricators are now available, which make an astonishing reduction in the rate of curve wear, incidentally creating a corresponding improvement in the performance of the rail.

From the early days of the railways and extending to a period well within the memory of even the younger men in railway service, the performance of rail was far from satisfactory. It is true that improvements were made over the years in the design of the sections, in the metallurgy of the steel, in the character of the joint fastenings and in other items. Yet the service to which the rail was subjected grew progressively more severe at the same or a faster rate than these improvements were made. In other words, up to almost the beginning of the last decade, rail never succeeded in catching up with the locomotive.

In the last few years, however, the quality of the rail has been improved and this development, together with better designs for the sections now in current use, has produced the best rail that trackmen have ever had presented to them. Added to this, most of the practices that have been mentioned have been developed during the last decade with a view of improving the performance of the better rail that is now being provided. In other words, the rail has now caught up with the locomotive.

The Rail of Tomorrow

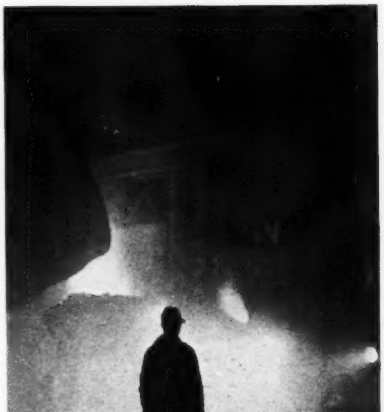
WHAT will the rail of tomorrow be like? What will be its shape? How much will it weigh? How long will it be? Will its composition differ from that of today's rail? Will the demands on rail in the future be more severe or less so than they are today? Obviously, any attempt at prophecy is hazardous; yet, these are not idle questions, for those who are responsible for maintaining the railways as a progressive transportation agency must have some knowledge of the trends that are taking place to enable them to plan wisely in order that they may not be outdistanced in the strenuous race in which all transportation agencies are now engaged.

No one can know with certainty of the future, but since trends do not start or end abruptly and since they can usually be discerned by those who seek them, an inkling of what probably will happen may sometimes be obtained by a review of what has already taken place. Such a review has been presented with respect to rail in the articles that have preceded this one.

What Will Be Its Shape?

Although a great variety of rail designs have been proposed as substitutes for the T-rail section, the railways upon which they were tried out returned sooner or later to the T-rail, despite the fact that it often labored under the handicap of a poor design, and while there have been many variations, there has been no fundamental improvement of the original design since it was first produced 110 years ago. It seems safe, therefore, to predict that the shape of the rail of the future will not differ fundamentally from that of today.

It has already been pointed out at some length how even the most competent engineers, with two exceptions, failed to understand that stiffness is an essential characteristic of rail. This lesson has now been learned thoroughly, however, and



Through the Co-operation that Exists Between Railway Engineers and the Manufacturers, Rail Steel of the Future is Bound to Continue to Improve

there is no reason to expect that at any time in the predictable future rail will revert to the low sections of the former period.

What Will It Weigh?

There is every indication of a continuation of the progressive increase in wheel loads and speeds. The 131-lb. rail now used so widely was designed to carry axle loads of 80,000 lb. at 80 miles an hour. Almost immediately it was seen that both of these limits, particularly that with respect to speed, were likely to be exceeded within the service life of the first of this rail to be laid. To be prepared for this eventuality, a section weighing 152 lb. to the yard was designed to carry axle loads of 100,000 lb. at 100 m.p.h. and a considerable amount is being laid.

Average Weight of Rail in Service in Main Tracks of the Class I Railways of the United States, 1920 to 1938 Inclusive.

As of Dec. 31	Average weight of rail per yard (pounds)	As of Dec. 31	Average weight of rail per yard (pounds)
1920	82.24	1930	90.78
1921	82.89	1931	91.29
1922	83.50	1932	91.63
1923	84.32	1933	91.92
1924	85.05	1934	92.34
1925	85.99	1935	92.72
1926	87.09	1936	a92.56
1927	88.09	1937	93.79
1928	89.08	1938	94.15
1929	90.09		

a Includes running tracks, passing tracks, cross-overs, etc. Data not compiled for main track only in 1936.

This is an era of speed, in which the schedules of all trains, both freight and passenger, will continue to be shortened. This is likewise an era of light-weight stream-lined cars, made possible by the development of alloys of steel and of aluminum. There is also keen competition between steam and Diesel-powered locomotives, and better designed and more powerful locomotives are coming out of this rivalry. Not a few roads have already reduced curvature and improved their track to permit sustained high speeds, and others are considering similar action for the severer service they can now foresee.

Higher Speeds a Factor

With better designed and more powerful locomotives, running over lines with flatter curves, both maximum and average speeds will be far higher than those of today and, despite the prospect of lighter cars, still stronger track will be necessary. In the consideration of this subject further study will be given to the determination of the section that is most economical from the standpoint of its effect on cost of maintenance and operation, an approach that was initiated in the study made by A. N. Reece on the Kansas City Southern and reported in 1930, and which showed that this road was warranted in using a section considerably heavier than that then in use. For all these reasons, it may be expected, therefore, that within the predictable future, rail may increase in weight to as much as 170 or 175 lb.

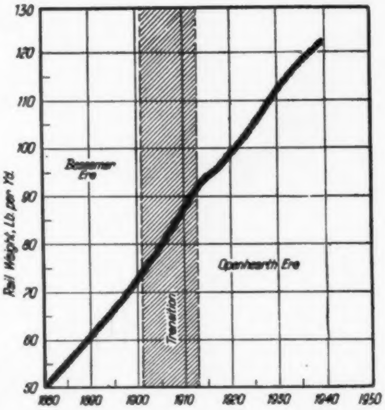
What About Length?

It has always been the desire of trackmen to eliminate or reduce the number of rail joints. Primarily for this reason, rails have grown longer slowly but progressively from the beginning of their use until the standard length is now 39 ft., and 78-ft. rails are now under observation by the Rail committee of the A. R. E. A. In the meantime, with the same viewpoint, but with another approach to the problem, several roads have undertaken to create still longer rails by butt welding rails of standard length to form continuous rails up to 6,900 ft. long.

Several of these installations are now under observation, with every indication that they are proving successful. For many years rails have increased in length as rapidly as cars have become available for transporting the greater lengths and this movement is sure to continue as the equipment becomes available, with the probability that the next step will be to 45 ft. and that this may not be far removed. Likewise, it may be expected that butt welding will meet with increasing favor as its advantages become better appreciated, and that the European practice of welding two or more standard-length rails together to form longer rails may come into vogue.

Will rail continue to be made of the same steel as at present? This question can be answered with less assurance than any of the others that were asked at the beginning. The reason for this is that there has been such astonishing progress in metallurgy during the last decade that it is especially hazardous to make predictions. Research in metallurgy is progressing today at a pace that has never been equalled, and no one knows when some discovery will be made that will revolutionize rail manufacture, as has been done by new alloys and thermal treatments in other fields. In any event, through a slow process of evolution, the rail steel of today differs greatly from that from which the first steel rails were rolled, and there is no reason to believe that this evolutionary improvement will not continue. Even since the first open-hearth rails were rolled 38 years ago, there has been a marked improvement in the quality of rails, although the chemistry of the steel does not differ fundamentally.

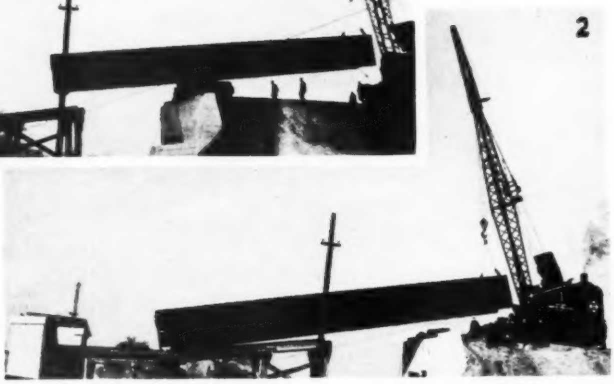
Barring developments in metallurgy that cannot be foreseen at present but which may occur at any moment, it may be predicted that the manufacturers will continue to provide more uniform, harder, tougher, better-wearing rails that are freer from defects and still more resistant to impact. In other words, regardless of possible revolutionary discoveries in metallurgy, the rail of the future will be as much better than the rail of today as today's rail is better than that of yesterday.

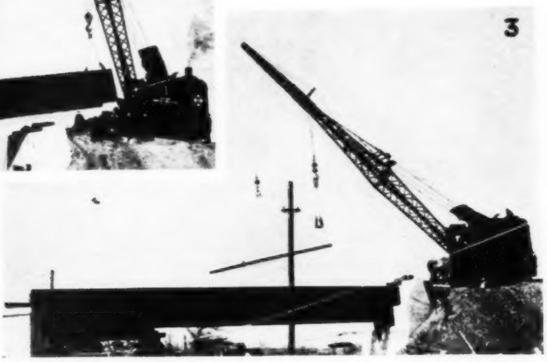


This Chart Shows the Continuous Increase Since 1880 in the Average Weight of Rails Rolled for the American Railways

Adapted from a chart prepared by H. H. Morgan, manager, Rail and Fastenings Department, Robert W. Hunt Company, and published in a copyrighted article in the July, 1940, issue of Metal Progress.

The Heavier, Speedier and More Powerful Locomotives of Tomorrow Will Demand the Utmost in Rail Quality.





(1) Nosing the Span Over Into a Position Free of the Car Truck; (2) Skidding the Span Forward on the Section of Temporary Trestle Provided; (3) Laying the Deck Ties and Track Rails While the Last Section of Temporary Trestle Was Being Removed

Places Long Girder Span With One Locomotive Crane

This article describes the novel method by which the Erie, seeking economy in the use of equipment, unloaded and skidded a completely-assembled 80-ft. deck plate girder span into place in a single-track spur, employing only one locomotive crane, a 70-ton car truck, and a section of temporary trestle

IN a novel and effective manner, the bridge forces of the Erie recently erected an 80-ft., 50-ton deck plate girder span as a unit. The span, brought to the site on cars, was placed from the track behind one abutment. To have placed it directly with a track crane would have required a crane with 50-ton capacity at 55 ft. radius. As no such crane was available, one of 50-ton capacity at 20 ft. radius was utilized in a special manner.

The occasion for this work was the construction of a spur track to serve a new industrial plant on the Greenwood Lake division of the road at Belleville, N.J., which involved the joint crossing of Second river and an old street roadway with an 80-ft. bridge span, and immediately adjacent, the crossing of a new street alinement with a 60-ft. span. New concrete abutments and a new concrete center pier were necessary for the crossings, but, to keep the expense of the bridge structure as a whole to a minimum, the railroad furnished two steel spans from its second-hand bridge stock.

For the river and old street crossing, the road supplied an 80-ft. deck plate girder span with square ends, which was completely riveted up, and which it was desired to erect as a unit, without dismantling. The only structural change necessary in this span to fit the conditions of its new use was to cut 31 in. from one end of one of the girders to provide a skew end over the center pier. The other span furnished by the railroad was a through girder span, which required considerable alteration to meet the new situation. This involved the lengthening of one of the girders 27 in., by splicing on a section at one end, and the flaring of the girders to accommodate a turnout in the new track layout, which extended onto this span. This latter work, in turn, required considerable alteration of the old steel floor system, but all of these changes were made at the structural shop maintained by the road at Port Jervis, N.Y.

Only One Crane Used

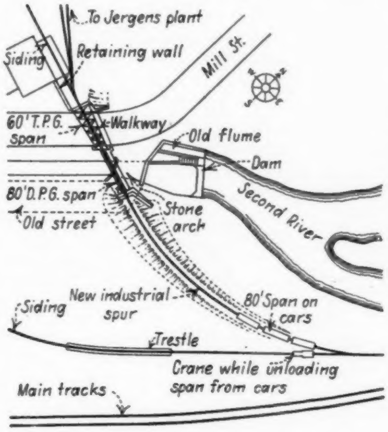
The new spur, with an overall length of about 700 ft., took off from a siding in a general westerly direction, on a curve of 13 deg. and on an ascending grade of 1.9 per cent extending to the new bridge crossing. With the completion of this part of the spur and the new bridge abutments and pier, the problem was presented of placing the 80-ft. deck girder span, without dismantling it, with one crane that was readily available to the work. Placing of the 60-ft. through plate girder span presented no special problem as it was erected piece by piece with the crane working

from the deck of the deck plate girder span after this span had been put in place.

The crane available for the work had a reach limited to 20 ft. for the 50-ton load involved in the deck girder span, and at a radius of 55 ft., which would have been necessary for the crane to have lifted the span ahead of it, it had a load capacity of only approximately 10 tons. Obviously, therefore, to use this one crane alone, required that a method be devised which called for no more than an end hold on the span. Briefly, the plan worked out to meet this situation involved the construction of a temporary trestle across the far half of the span opening, the mounting of the girder span slightly off center on a car truck for movement to the point of installation, the tilting of the advance end of the span downward to a support on the temporary trestle, and then, using the crane at the rear end as a hoist and a pusher, the skidding of the span forward to its final position on the new pier and abutment.

Moved on Car Truck

The span was brought to the site of the work on three flat cars, and the first problem was to remove it from the cars and mount it on the car truck. In meeting this problem, advantage was taken of the turnout of the new spur from the siding serving it, where, with the crane located on the siding just beyond the clearance point, it could reach over and lift the span from the cars which were spotted on the spur. Freed of the span, the cars were then pulled backward out onto the siding, and the car truck to carry the span forward to the bridge site was moved beneath the span to a point 2 ft. off center, with the longer end of the span toward the rear, or away from the bridge site. The truck used was a standard 70-ton car truck, which, to give suitable support to the girders of the span, had been equipped with 8-in. by 10-in. timbers, 8 ft. long, cut to fit and mounted longitudinally over each of the side frames. These timbers were secured to the frames at four points by means of U-bolts. When the span had been lowered into position on the truck, it was secured in place by means of ⅞-in. bolts, four to each girder, passed through the bottom flanges of the girders and the truck frames.



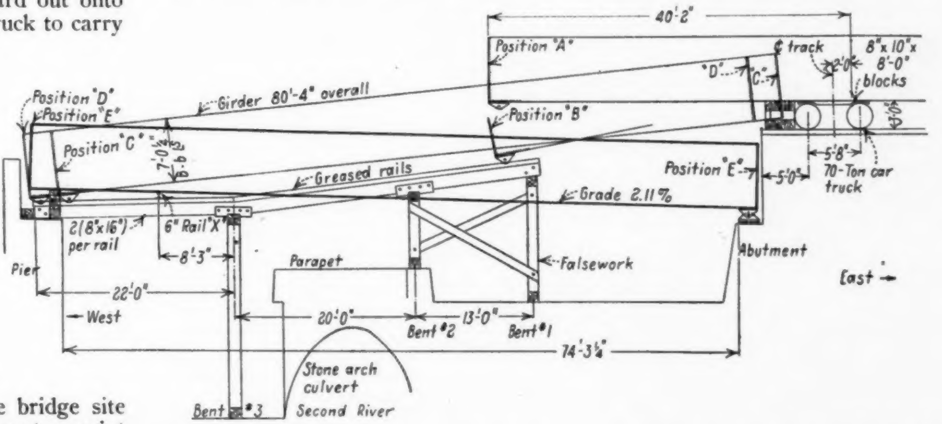
General Situation Plan Involved in the Bridge Erection Work

With the span secured on the truck, the crane moved backward through the turnout and then forward to a position directly behind the rear, or east, end of the span. At this point the crane hook lifted the unbalanced end of the span to a level which made it convenient to attach to the west ends of the girders the upper castings of the pedestals upon which they were to rest when in final position. These castings, with their bearing pins in place, were fixed to the girders at this stage of the work because of the subsequent detail of the plan which involved the use of the bearing pins as skid shoes on the section of temporary trestle when moving the span forward into final position.

With the pedestal upper castings in place, the crane, while lifting the unbalanced end of the span, pushed the span forward to the bridge site to a projecting position over the bridge opening, as indicated by "A" on the accompanying work sequence plan. When position "A" was reached, the crane raised the rear end of the span free of the car truck on which it had been moved, causing it to fulcrum over temporary timber cribbing placed on the backwall of the abutment, until the advance end of the span came to rest on the temporary inclined trestle skidway which had been built over the far half of the opening between the abutment and the pier, as is shown by position "B." Then, with the whip line of the crane attached to the span to control its forward movement, the span was pushed slowly forward by the crane into position "C." Snubbed in this position by means of a cable attached to the capstan on the crane, the rear end of the span was given support on wood blocking on the abutment backwall. While in this position, that section of the temporary trestle between bents No. 1 and 3, which projected above the final low clearance limit of the structure, was removed, and then, after a section of track rail had been slipped transversely beneath the span at position "X," 8 ft. 3 in. west of temporary bent No. 3, to serve as a fulcrum, the east end of the span was lowered into position "E" on the abutment seat and was attached to the expansion-type bridge shoes which had been set in position previously.

With the west end of the span now held upward slightly by the transverse section of rail at point "X," this end of the span was jacked clear of the falsework and given support on wood blocks placed under the end cross frame, thereby permitting the removal of the trestle. With the trestle out of the way, the load at the west end was transferred to timber blocking placed beneath each girder, directly in front of the pedestal locations. Then, while part of the bridge gang laid the bridge deck and rails with the aid of the crane, other men

Elevation, Showing the Sequence of Operations in Skidding the 80-Ft. Span Into Position



jacked up the west end of the span to place and anchor the lower castings of the bearing pedestals, and then lowered it into final position.

All of the work involved in placing the 80-ft. girder span, including the removal of all of the falsework, but not its erection, was done between 7 a.m. and 4 p.m., with time out for dinner. With the completion of this phase of the work, the adjacent through plate girder span was erected piece by piece with the aid of the crane working from the deck of the 80-ft. girder span already in place.

The planning of the work involved in this project and the erection of the 80-ft. deck plate girder span were done under the direction of G. S. Fanning, chief engineer of the Erie, assisted by F. A. Howard, engineer of structures, A. M. Knowles, assistant engineer of structures, and Carl Kohler, supervisor of bridges. The erection of the through plate girder span was done under contract let by the company for which the industrial track was built.

What Causes Paint to Alligator?*

By J. P. St. George

Technical Service Division,
Research Laboratories,
National Lead Company, New York

AS applied to paint or varnish coats, the term alligatoring is used generally to indicate that defect characterized by the formation of interlacing lines of cleavage in the top coats of a paint or varnish film. When these lines are fine and close together, the defect is usually called checking. If the lines of separation are fairly wide and the enclosed areas are rather large, the painted or varnished surface will resemble the hide of an alligator. In other words, alligatoring is simply an aggravated form of checking.

Same Basic Cause

Both checking and alligatoring result from the same basic cause, that is the application of a hard-drying top coat over a relatively soft under coat or under coats; or by the application of a correctly formulated top coat over a correctly formulated under coat while the under coat is still soft. In one instance, improper formulation of either the top coat or the under coat is usually the cause; in the other, the trouble must be attributed to insufficient drying time between coats.

Examples of alligatoring are easy to find, particularly on buildings and equipment of industries in which time is a highly important factor. In such industries proper maintenance is obviously necessary, while in some instances time is limited, but perhaps there has been a slight overemphasis on the speed element. When a building is to be painted, a definite time limit is usually set and, in many cases, the time allowed is not sufficient to allow for first-class work. The painter is forced by the terms of his contract to rush the painting, and this is not advisable. As a result, the under coat is just about "set," but not thoroughly dry and hard, when the finishing coat is applied. The application of this finishing coat, regardless of its composition, will stop the drying of the under coat. The finishing coat itself continues to dry, however. It is well known that all paints and varnishes containing drying oils shrink slightly as they dry and harden.

Under normal conditions, when the finishing coat has been applied over a hard, thoroughly dry under coat that has been formulated correctly to provide tooth for the finish, the slight shrinkage that thus occurs results in a negligible reduction in the thickness of the top coat. When the under coat is soft, however, the top coat usually ruptures, and the interlacing lines of cleavage begin to appear.

As already stated, when these lines are fine and close together, the phenomenon is called checking. In its milder form this is not a serious defect, because it is noticeable only upon close inspection and does not affect the durability or the protective ability of the coating. When the aggravated form, alligatoring, occurs, the defect is serious because it is usually necessary to remove all of the old paint from the surface before a satisfactory job of repainting can be accomplished.

Even though the right materials are used, care must be exercised to combine them properly to insure good drying and hardening. Here and there one finds an old-timer who figuratively, if not literally, holds up his hands in horror when the use of turpentine is suggested for the priming coat. According to his viewpoint, only linseed oil must be employed in priming. Obviously, an excessive amount of lineed oil or of any other nonvolatile-drying oil, used in under coats, tends to produce a soft film. When the finishing coat is applied over the soft surface, checking or alligatoring will occur inevitably. Since, by the judicious use of turpentine or mineral thinner with the linseed oil and white lead, it is possible to provide a thin primer, the old straight-oil practice is now followed by few, if any, master painters.

Some oleo-resinous varnishes display a tendency to produce a soft film. As repeated applications of these varnishes are made, the alligatoring that is bound to occur, becomes worse and worse. Examples of this may be seen on the woodwork of ferry boats and on the interiors of many of the older railway passenger cars. At first, these varnishes were used principally for economic reasons, that is, low cost, but because it was necessary to remove the coatings before revarnishing, the falseness of the economy became apparent. At present, much better products are being employed, and the alligatoring of varnished surfaces is not seen so frequently now.

Precautions Necessary

By observing the two precautions that follow, it is possible to avoid alligatoring.

1. Make sure that the under coat is formulated properly, whether it be paint or varnish, so that it will provide a good hard film, not brittle, but with just enough elasticity to enable it to conform properly with the expansion and contraction of the material painted.

2. Allow ample time to elapse between coats, taking into careful consideration the weather, the general drying conditions, the nature of the materials employed, and other governing factors.

These precautions might not be considered to be so simple by maintenance officers, if it were not for the fact that progressive manufacturers of paint materials, varnishes and other coatings are both ready and willing to help them. They are in the best possible position to give these officers authoritative information concerning coating materials, their formulation, their application, their drying time and other factors involved in the protection and beautifying of all types or surfaces.

*This discussion was submitted for publication in What's the Answer department in answer to a query as to what causes paint to alligator, and what can be done to overcome the trouble. Because of its comprehensive character, it was withheld for presentation here as an independent article. For further discussion of this subject see page 198 of the March issue.

WHAT'S the Answer?

Driving Back Rail

What hazards are involved in driving rail to secure expansion? How can they be overcome?

Prefers Another Method

By H. R. Clarke
Engineer Maintenance of Way, Burlington Lines, Chicago

In addition to driving rail to secure expansion, it may also be driven to close up expansion or properly to "break" or square up joints and I suppose the hazard, if any, is the same in all cases. Rail is usually driven by striking an angle bar with a piece of rail of a length suited to the number of men available to handle it. Unless care is used, it is possible to damage the angle bars and to stretch and bend the bolts; the rail may also be overdriven. However, I would not consider any of these as hazards. Seemingly the only actual hazard is that of possible injury, such as bruised or cut hands or feet or injuries, especially to the eyes, caused by flying pieces of steel. All of these can be avoided so easily by exercising reasonable care, handling the driving rail with tongs in such manner as to insure striking the angle bar squarely and directly without glancing or sliding and by the wearing of goggles, that I do not consider this a hazardous undertaking at all.

There are conditions under which it may be necessary to drive rail, but a large part of this work may be avoided by removing the rail anchors and loosening the joint bolts to permit the rail to move itself. This should be done when the temperature is such as to bring about the movement in the desired direction. Moreover, this action may be assisted by the proper setting of the rail anchors and when the desired adjustment has been brought about, the anchors should again be set in the proper position and the joints should be tightened. I think this method of adjustment is to be preferred to the driving of rail.

Supervision Necessary

By E. L. Banion
Roadmaster, Atchison, Topeka & Santa Fe, Marceline, Mo.

The necessity for driving rail to secure expansion openings results from improper or inadequate rail anchorage. Not only will the rail bunch and become tight at the foot of grades under such conditions, but this movement also causes excessive end openings at the summits. Several methods are used in driving rail to secure a uniform distribution of expansion openings. The most satisfactory means of overcoming the difficulty involves taking the rail up and using the prescribed expansion shims when relaying it. Afterwards a sufficient number of rail anchors should be applied to hold the rail in place.

Since this method is rather expensive, a much less costly operation is commonly used, that of driving the rail in place. Rail anchors and joint spikes in the affected territory are removed and, starting at the first joint in the tight section of rail adjacent to the joint having the greatest opening, men, grasping a short section of rail with rail tongs, use it as a ram, and strike the joint bar near its base. The rail moves forward and the action is repeated as often as necessary to secure the desired gap at the opposite end of the rail. When the desired closure is made the driving gang moves to the next joint away from the wide opening and repeats the operation until all joints have been driven up. However, it is usually necessary to go over the same rail several times in order to secure the uniformity of expansion desired.

Send your answers to any of the questions to the What's the Answer Editor. He will welcome also any questions you wish to have discussed.

To Be Answered in November

1. *To what extent should the supervisor and division engineer participate in the annual tie inspection? Why?*

2. *What relation should be maintained between the risers and the treads of a stairway? Why? When should a ramp be substituted for a stairway?*

3. *When laying rail, is it good practice to adze ties on curves to obtain more cant for the inside rail than is afforded by the cant of the tie plates? The outside rail? Why? How much?*

4. *How does one determine when a wire rope needs to be replaced? What are the most common causes of failure?*

5. *What is the most satisfactory type of snow broom? Are detachable handles practical?*

6. *What steps are necessary to provide faster delivery of water to large locomotive tenders?*

7. *Should track shovels be bought to railroad specifications or selected by brand name? Why? Do the test requirements of specifications insure satisfactory shovels? If not, what forms the best basis of selection?*

8. *What species of lumber are best suited for staging and scaffold? Why?*

Care must be exercised to avoid damage to the joint bars and bolts by excessive driving. Moreover, the entire operation can be speeded up considerably by using a rail crane for the driving operation. Hazard of injury to men engaged in the work is negligible if supervision is adequate.

Uses Safe Bearings

By Victor H. Shore
Yard Foreman, Atchison, Topeka & Santa Fe, Dodge City, Kan.

Rail is usually driven by a gang using rail tongs and a length of rail as a ram; the safety of the operation depends upon adequate supervision and the use of proper bearings for the sliding rail. The use of lining bars or others which cannot be securely fastended to the ties is objectionable for the reason that personal injuries may result from the shifting of such supports during the driving operation. A safe arrangement includes the use of two flat iron bars about three feet long, provided with caulks on the underside at each end. When fastened to the ties, between the rails, and about four feet from each end of the rail being used as a ram, these bars provide adequate bearings which will not slip out of place and which may be removed readily and reset at different locations.

The men who are placed next to the striking end of the ram should be selected for their experience and the care with which they conduct their work. Furthermore, I believe that the driving should be done with the ram rail in position between the track rails, wherever practicable, because good footing is provided for all members of the gang, the ram rail can be moved to each succeeding location more quickly and safely, and where it is necessary to drive the rails on both sides of the track this can be accomplished without the necessity of crossing the track rails.

Why Air-Relief Valves?

What are the advantages, if any, in placing air-relief valves at high points in pipe lines? How high should the crest be to warrant the installation? Are there disadvantages?

Insure Regular Flow

By J. H. Davidson
Water Engineer, Missouri-Kansas-Texas, Parsons, Kansas

Water always contains air in either dissolved or mechanically entrained forms or both. Hence if a water line contains summits and depressions, air will be released gradually and will collect to form pockets at the summits; these will decrease the effective cross section and will reduce the delivery of the pipe under a definite pressure or head. If the capacity of the pipe line is to be maintained under these conditions, it will be necessary to increase the pressure at the pumps, which increases pumping costs.

Steep slopes and low water velocity induce the separation of air from the water and therefore in these instances more trouble will be encountered from air-binding. If the air is not released from the summits it will gradually restrict the flow and unless the pressure can be increased sufficiently the flow will be stopped entirely. To insure a regular flow of water and to guard against an increase in pumping costs it is advisable to install air-relief valves at all summits in pipe lines.

Ordinary valves may be used and operated by hand but operating labor requirements are usually too great. Automatic valves are available and give satisfactory service. They should be installed at the end of a short piece of connecting pipe, with an ordinary valve intervening so that the relief valve may be removed readily for repairs. They should also be protected from freezing. The disadvantages of air-relief valves are the small additional cost of installation, inspection and maintenance.

Promote Efficiency

By E. M. Grime
Engineer of Water Service, Northern Pacific, St. Paul, Minn.

The placing of an air-relief valve at the high point in a pipe line is not only an advantage but a necessity if efficiency in pumping is desired. Normally there is some air in water. With the disturbance which occurs as the water passes through the pipe line, a part of this air may be released, and to this will be added a certain amount of air which becomes entrained with the water through the operation of the pump. The amount of air drawn through the pump will depend on the type of equipment in use; some pumps draw in more air than others. This free air, or other gases which may be released from the water, will collect at the highest point in the line and constrict the pipe to practically the same extent as any solid substance. The result is therefore the same as if a smaller pipe were in use.

It is not possible to make a definite statement as to when an air-relief valve is necessary; its use depends on local conditions. A good way of determining the necessity for a relief valve is to calculate the theoretical friction head in the pipe line, considering its age and condition, and to compare this with the friction determined by the pumping record. The difference in power consumption will show the monetary loss caused by pumping against a head which is greater than it should be. This will indicate that the installation of an air-relief valve will probably justify itself within a short time.

The disadvantage of a relief valve installation is the slight increase of cost for maintaining due to inspection, adjustment, and in some cases protection against the effects of freezing.

Safety Requires Installation

By C. R. Knowles
Superintendent Water Service, Illinois Central, Chicago

Air will accumulate at high points in pipe lines with the result that the flow of water is restricted, pressure is increased and delivery is decreased, particularly where centrifugal pumps are used. Air-relief valves should always be placed at summits of pipe lines. These valves allow the air to escape when water is being pumped and also permit air to enter when the line is emptied, thus preventing the formation of a vacuum which otherwise might be sufficient to cause the collapse of a large pipe line with thin walls.

There is no fixed rule whereby the height of the crest warranting the installation of an air-relief valve can be determined. Generally, however, safe practice demands installations at all crests. The contour of the pipe line forming the crest should be considered; for example, a long easy slope to the crest with an abrupt drop be-

yond would, perhaps, be the most serious condition encountered, whereas a long easy slope beyond the crest might permit the air to escape without the use of an air valve.

There are no particular disadvantages attached to the installation of air-relief valves other than those associated with any opening in the line. In deep trenches it is sometimes the practice to install enclosure pits to provide access to the valves. In other cases a pipe is extended from the pipe line to the air-relief valve which is placed near the surface of the ground.

A common type of air-relief valve comprises a cast iron cylinder, varying in length with the depth of the trench, and attached to the pipe line by means of a pipe nipple. The top of the cylinder is fitted with a removable head which has an opening in its center through which the air escapes. Attached to the inner side of the head is a brass cage containing a hollow brass or hard rubber ball. Air which accumulates in the pipe line passes up through the cylinder and out the opening. As the air is exhausted, water enters the cylinder, the ball floats on the surface until it reaches the seat and closes the opening. When air collects again, the ball drops back into the cage and the operation is repeated. Other types of air valves operate with levers and floats, but the same general principle applies to the operation of all.

Left-Over Building Materials

What disposition should be made of material left over when a building job is completed? Of usable second-hand material? Why? Who shall be responsible?

Return to Storehouse

By Frank R. Judd
Engineer of Buildings, Illinois Central, Chicago

When the average building job is completed, there should be very little, if any, new material left over, unless various changes from the original plans were made during the progress of the work. If there is any new usable material left over, the superintendent or foreman in charge of the work should be responsible for seeing that it is properly taken care of and turned over to the stores department and held in stock by them until required.

The taking care of usable second-hand material left over from a building job should also be the responsibility of the superintendent or foreman on the work and if there is a sufficient quantity of this to warrant the expense of handling and loading, it should also be turned over to the stores department.

Care Eliminates Excess

By A. G. Dorland
Assistant Engineer, Elgin, Joliet & Eastern, Joliet, Ill.

Care and judgment should be exercised to eliminate, if possible, any left-over material after the building is completed. This can be accomplished, to a large extent, if track facilities are close to the site, for then materials can be retained in the cars and unloaded as needed. This system applies particularly to the use of gravel, sand and cement. If the building is comparatively large, lumber also can be handled in the same manner, especially when it is purchased and delivered directly to the job; if this lumber is received in foreign cars it may be economical to transfer it to company-owned cars. In such instances the exact amount of the various sizes and grades of lumber required for the job will be shipped in the cars. If, however, the lumber is loaded from stock it may be shipped in separate cars from several points, thus necessitating unloading at the site of the building; but if estimates are properly prepared this should not involve any excess material. If it is necessary to unload the material, either because of lack of track facilities or on account of the necessity of releasing the cars, care should be exercised to unload only a slight excess over the quantities of material needed, as indicated in the detailed estimate for the project.

Consideration should be given as to whether usable scrap and new materials, which remain after a job is completed, have a salvage value in excess of the cost of recovery. If so, the method of recovery depends upon the location of the job and its proximity to centers where such materials are stored. Several methods of recovering excess material may be used: (a) Have a stock car with the outfit cars so that materials can be loaded as they are recovered. (b) Hold such materials in neat piles until there are sufficient quantities to make it economical to use a work train with loading equipment. (c) Scrap lumber should be destroyed at the site unless its use for firewood, bulkheads or cribbing might make it economical to load. Otherwise such lumber may be given to a needy person, preferably an employee, who will remove it without any expense to the railway. (d) Small quantities of either new or usable material can generally be taken to the nearest freight house and consigned to the stores department. (e) The foreman on the job should be responsible for the disposition of all excess material or should report to his superior so that proper steps may be taken to dispose of it.

Contractor Responsible

By O. G. Wilbur
Field Engineer, Baltimore & Ohio, Baltimore, Md.

On the basis of our experience, the logical method of disposing of material left over when a building job is completed is to require the general contractor to remove such material and turn over the premises completely cleaned up and ready for occupancy. This procedure eliminates all argument as to where one man's responsibility ends and the other's begins. It further eliminates the necessity of depending upon company forces to dispose of material that would undoubtedly be in the way until such time as other seemingly more important work is finished.

If the contractor is made responsible for cleaning up after construction work is completed and realizes that final settlement will not be made until he has fully complied with the terms of the contract, he will not ordinarily let this cleaning up process go until it suits his convenience. The engineer in charge for the railroad has the final phase of the work under his control, whereas if he must depend upon a branch of his railroad organization to do this work, he probably does not have complete control of the situation. It is doubtful if the salvage of reclaimed unused material would justify the railroad force assuming the

responsibility of cleaning up after completion of a building construction job by a contractor.

No Material Wasted

By L. G. Byrd
Supervisor Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

It is our practice to keep a small amount of building material with each outfit in order to carry out our program work as the gangs proceed over the various districts and divisions. When new jobs involving buildings of various sizes are authorized, the plans are checked very carefully to avoid as much waste as possible, as well as to avoid the accumulation of additional material. Therefore, when the jobs are completed very little material is left over. If the left-over material is new and it is not needed immediately, it is returned to the nearest store room or to those handling such material so that it can be disposed of at other locations.

It is our practice to apply the same care to good second-hand material as to new material. It is placed on outfit material cars and is used in making general repairs to various kinds of structures. When the accumulation exceeds the quantity needed for repairs, it is transferred to other divisions to save the purchase of new material. When it is available, we often use a large amount of second-hand framing material in new structures. The foreman and supervisor are held responsible for the care of both new and second-hand materials.

How to Inspect Rail

Should section foremen be required to make detailed inspections of rail for indications of approaching failure on lines over which detector cars are being operated? If not, why? If so, how often and in what detail?

Examination Necessary

By G. Stafford
Section Foreman, Canadian National, Redland, Alberta

Notwithstanding the high standard of efficiency that has been attained in recent years in the detection of approaching rail failures by the operation of detector cars over the tracks, detailed inspection of the rails at frequent periods must necessarily continue to be one of the most important duties of the section foreman. To my mind it is not a question of the efficiency of the detector car or of the scope of its operation; these have been fully established since its inception some twelve years ago. The point is that, chiefly for economic reasons, detector cars cannot be operated over tracks with sufficient frequency to insure that dormant defects have not developed into a state of dangerous activity. It must be borne in mind that the majority of rail defects have a nucleus in the beginning; this may remain static for a long period, then in consequence of some changed condition change from a state of incipiency to one of malignancy within a short time.

The frequency of such detailed inspections will depend upon the physical conditions of the section, the density of traffic and the length of time between the visits of the detector car. If the car is operated over his section bi-annually the foreman should be required to inspect the rail on his section every two months and frequency of inspection should be made in inverse ratio to the frequency of the tours of the detector car.

Detailed inspection should be carried out by the section foreman himself and not delegated to one of his subordinates. It involves a thorough examination of the head, web and base of each rail in the track, a search for indications of incipient fracture or of defects of progressive growth. Potential failures that may occur in the head of the rail in the order of their importance are: the transverse fissure, the head check, the horizontal split head and the vertical split head. The web may be subject to cracks, splits, bolt hole breaks and pipes. In the base of the rail may be found the progressive seam fracture and the moon-shaped break.

One Supplements the Other

By C. B. Bronson
Inspecting Engineer, New York Central System, New York

Regardless of whether detector cars are being operated in a given territory, I believe that there is no one who doubts that section foremen and their men must be constantly on the alert, in their regular trips over their territory, for signs of impending or possible failure of rails. This in a measure means general or constant inspection; it is of prime importance and cannot be delegated to detector car inspection.

The discussion of detailed inspection can best be illustrated by examples. Certain territories have been practically immune from fissures, regardless of the age or length of service of the rail; at other locations their number and frequency of occurrence have been relatively high. Mirror inspection, by section forces or others, at intervals between successive detector car inspections has, in many instances, located cracks beneath the rail head. The timing of this form of inspection depends upon the interval between detector car inspections and frequency records.

The same thing is true of split head rails which comprise the next classification of general importance. Again it is necessary for section foremen to rely upon surface appearances which indicate the breaking down of the metal and the progress of the vertical split. Mirror inspection in such territories is helpful in detecting many cases in which the split has progressed to the fillet; however, it may not be necessary to inspect all tracks on the section by this method if failures are few. Many foremen are not equipped with a magnifying mirror on a dolly frame which may be pushed along one line of rail and it is then necessary to conduct the examination by sighting beneath the rail head to detect any appearance of breakdown.

Irregularities in the brightness of the top of the rail furnish alert foremen and their men with evidence of failure, particularly of the vertical and horizontal split head types, crushed heads, and bad burns where the structure is breaking down. Horizontal rust streaks on the side of the head indicate horizontal split head failure which is often the forerunner of compound fissures. Vertical or diagonal rust streaks indicate burns which may lead to so-called progressive fractures and those must be watched for, particularly in those stretches known to be troublesome. The frequency of the detailed inspection should be based upon the history of the rail, particularly when fillet cracks and crushed or split heads occur in rails on curves; it should also be based upon judgment and experience rather than upon set intervals and it may be required several times between detector car operations.

There are several types of defects that are beyond the scope of the detector car and which require constant or general inspection as well as de-

tailed inspection. For instance at certain locations half moon breaks in the base are prevalent and since they lead to complete fractures, detailed inspection is necessary. I know of cases of rail failure from half moon breaks during midwinter when it was necessary to remove snow which covered the track up to the top of rail so that detailed inspections could be made and rails with partial or complete moon breaks were removed at once rather than awaiting the coming of spring. Bolt hole breaks may be prevalent in certain localities and detailed inspection may require the removal of joint bars to facilitate examination. The same course may be required in localities where brine drippings have so weakened the base of the rail that it is necessary to search for cracks.

It is evident that no hard and fast rule can be applied to cover the inspection of all types of defects by track forces. All concerned must be constantly on their toes, regardless of whether the detector car has been over the track or not or when it is expected. The degree of watchfulness must be increased on those stretches of track where history or past experience indicates an abnormal number of defects. Attitudes which must be combatted include that of waiting to see what the detector car will do toward cleaning house instead of beating the car to it, as well as that of the section forces assuming a period of relief from close watch and inspection immediately following the operation of the detector car.

Again I wish to emphasize that the vigilance and watchfulness of section forces should not be delegated to the detector car. One service supplements the other and the car is the helpmate of the section foremen and their men. While these forces have many and varied duties, apart from looking for defects in rail, there is nothing of greater importance than the removal from track of rails which may develop unsafe conditions. Detailed inspection may not be necessary for all tracks, but it is essential for locations which are known to be troublesome. The time to conduct the inspection and its extent depend upon the type of defect and the results of careful observations from day to day.

Do Not Abandon or Relax

By C. W. Baldridge
Assistant Engineer, Atchison, Topeka & Santa Fe, Chicago

The detector car is a very great aid in finding rails which are developing cracks or flaws that are quite sure to produce rail failure and it is therefore very much worth while. In occasional cases, however, a joint, a driver burn, or a spot of dirt or grease on the rail gives an indication which concurs, or so nearly concurs, with the indication caused by a flaw or crack that the operator of the car is deceived and thinks that the real indication is false. Also, cracks in rails sometimes develop quickly and such cases may occur shortly after the detector car has passed over the track, with the result that a rail break occurs before the next trip of the car.

In addition to the cases mentioned, there are some types of flaws or cracks which are not likely to cause an indication by the detector car—such as cracks in the base or sometimes in the web of the rails, particularly fillet cracks which develop just at the bottom of the fillet between the underside of the head of the rail and the top of the web. Also head checks or detail fractures, which develop in the gage edge of the face of the rails, most frequently in the low rail of curves or on heavy up-grade track, but sometimes even in tangent tracks, will, in some cases, fail to register on the detector car tape and yet will develop into a break within a short time.

The detector car should not be depended upon to the extent of abandoning, neglecting or relaxing personal inspection of the rails by the section foreman and also by the roadmaster, and track laborers should be schooled into always keeping on the lookout for cracks or defects in rails. The question of how often such inspections should be made cannot be fixed arbitrarily in an article of this kind, for the reason that the importance and speed of trains and the amount of traffic passing over the track must govern the frequency of inspections. If inspections are ordered to be made on a comparatively light traffic line as frequently as on a more important and heavy traffic line, either unnecessary inspections are being made on the one or insufficient inspections are being made on the other. Of the two, however, excess inspection is preferable. The best personal inspections of the underside of the rail head and the web can be made by the use of a mirror, preferably one which magnifies the objective.

What Type Bulkheads?

What are the relative advantages of concrete walls, concrete plank and creosoted-wood plank for bulkheads for open-deck trestles? For ballast deck trestles? Are there any disadvantages?

Location a Factor

By G. L. Staley
Bridge Engineer, Missouri-Kansas-Texas Lines, St. Louis, Mo.

There can be slight, if any, disadvantage in having concrete wall bulkheads at the ends of open deck timber trestles. At some locations such as low trestles resting on rock, for instance, it is sometimes about the only form of end bent that can be kept in place. Ordinarily it is out of place in this type of bridge, as the service life is unnecessarily long compared to that of the rest of the structure. There is little reason for using concrete planks in bulkheads, for creosoted timber is as permanent as the other parts of the bridge and serves in this capacity as long or longer, on the average, than the timber that carries the trains. The disadvantages of timber are those inherent in timber at any location, eventual decay and some fire hazard. In selecting the type of bulkhead, the location of the structure is the determining factor and I can see no distinction between open deck and ballast deck trestles. In most cases trouble has resulted from trying to maintain an end bent which is inadequate rather than from the material of which it is built.

Prefers Creosoted Plank

By S. F. Grear
Assistant Engineer of Bridges, Illinois Central, Chicago

We are all inclined to prefer a form of construction with which we are familiar, and possibly this is the reason for my preference for creosoted wood plank. A concrete wall of substantial section would, without doubt, be a satisfactory bulkhead, but it would be quite expensive and would, ordinarily, require temporary supports for the track during the construction and curing period. This would also delay the completion of the trestle.

Concrete plank can be placed in the same manner as creosoted wood plank

and there should not be much difference in cost. Concrete plank requires more care in handling to prevent damage. Creosoted wood plank can be shipped to the job with the remainder of the creosoted material, can be handled easily by hand, and is not as liable to damage in handling. These timbers are easily fastened to piling and to each other and if well creosoted will, in my opinion, outlast concrete planks of similar thickness. In many cases, it is necessary to increase the depth of bulkheads and this can be done easily with wood. Concrete walls and concrete plank have the advantage of being fireproof, but I would not consider this important for a bulkhead when the rest of the bridge is not fireproof. Any advantage or disadvantages are the same for either ballast deck or open deck trestles.

Vitrified Pipe Under Crossings

Is vitrified clay pipe suitable for use under highway crossings? Private crossings? If not, why? If so, under what conditions?

It Is Satisfactory

By L. G. Byrd
Supervisor Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

Experience with vitrified clay pipe for a number of years has proved beyond a doubt that it is one of the most economical drainage materials that can be used under highway and private road crossings where the soil conditions are suitable for supporting the pipe and where the covering material is maintained to a depth of 2 ft. or more. We still have a large number of double strength vitrified clay pipes varying from 12 to 30 in. in diameter in service under our roadbed. The embankments vary in depth from 3 to 25 ft. and the culverts are still satisfactory after many years of service. Vitrified clay pipe can be installed without the use of skilled labor and the material cost is comparatively low. However, when openings greater than the equivalent of a double line of 36 in. pipe are required under highways and private crossings, it is our practice to use other kinds of permanent material.

Modern Pipe is Stronger

By T. M. Pittman
Division Engineer, Illinois Central, Water Valley, Miss.

For many years practically all pipe used under road crossing approaches to railroads was of vitrified clay and the service was generally satisfactory. In more recent years, because of the development of heavy wheel loads on highways and the introdution of other culvert materials, the use of vitrified pipe has decreased, perhaps by reason of idea that metal pipe is stronger or more uniform in its texture.

As a rule these lines of pipe are so short that the hydraulic characteristics are not important. The main considerations are strength, durability and cost. The manufacture of vitrified clay pipe has been perfected so that the product is uniform—the wall sections are thicker, and it possesses greater strength which can be depended upon within reasonably narrow limits.

Like any other pipe its service depends upon the care with which it is laid. Generally the minimum depth of covering over the top of the pipe should be equal to the diameter and with this protection the higher strength vitrified pipe will support a load of 2,000 lb. per lineal ft. of pipe for each foot of diameter; in other words a 12-in. pipe with 12-in. covering will carry a load of 2,000 lb. per square ft. and a 24-in. pipe with 24-in. covering will carry 4,000 lb. per square ft. These figures seem to be based on general experience and the assumption that the pipe will be carefully laid in a solid-wall trench excavated to fit the pipe, with holes dug out for the bells, with the joints carefully cemented and the back fill well tamped, at least up to the center line of the pipe.

Clay pipe is fireproof and it will not rust in the usual sense of the word. Some of the older pipe, however, weakens after long service; it will continue to serve its function if it is not disturbed, but in many instances it will crumble at the first attempt to remove or alter the line. The tendency of vitrified pipe to absorb moisture has been reduced by improved manufacturing methods and its resistance to abrasion also compares favorably with any other type. The cost depends upon local conditions but a big factor is the care with which the joints have to be built and the weight of the pipe, which not only increases transportation difficulties and costs, but also restricts the length of the pipe and necessitates more joints. In general, it can be said that vitrified clay pipe has served a useful purpose under road crossing approaches, both public and private, in a satisfactory manner and is suitable under modern conditions if ordinary care is exercised in its use.

Removing Scant Weed Growth

What is the best method of removing a scant growth of weeds and grass from stone ballast? From gravel ballast? What are the advantages? How does the cost compare with other methods?

Depends on Growth

By L. L. Adams
Engineer Maintenance of Way, Louisville & Nashville, Louisville, Ky.

The word "scant" as used in this instance is subject to wide variation and for that reason it is impossible to give a definite answer to any of the questions. Where the growth of weeds and grass is such that four laborers can weed as much as 1½ miles of track per day by the use of shovels, scuffle hoes and grassing blades, the cheapest method of removal is by hand. But if the growth is heavier and this amount cannot be weeded in a day, then it will be economical to resort to some other method. The most economical method will depend on the nature and location of the growth to be removed.

Where ordinary weeds and grass are growing in the border outside of the rail, discing is an effective and economical method of removal. However, this method is not effective in eradicating certain weeds, such as Bermuda grass, for discing the ballast seems to have a tendency to cultivate such grasses and to make them grow more prolific than before discing.

Where the growth is in the center of the track or covers the entire ballast section, it is more economical to resort to chemical spray or burning, both of which have proven effective

and reduce the growth of vegetation if used at regular intervals. In using either of these methods, the application can be regulated where necessary so that even a relatively scant growth of vegetation can be removed at reasonable cost.

In removing the grass and weeds from gravel ballast, scuffle hoes or grassing blades are the most economical tools to use, whereas in rock ballast it is usually necessary to use shovels or to remove vegetation by hand pulling. As the cost of killing vegetation varies greatly with the density of growth, it is practically impossible to give any comparative cost data for doing this work by any given method. Each individual problem must be considered separately and the method best suited to the particular requirements should be adopted.

Clean Ballast Essential

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

While many different methods of weed eradication are practiced, including chemical sprays, burning, discing, pulling and weeding by hand with shovels and scuffle hoes, nevertheless the fundamental consideration is the removal of dirt from the ballast, for in this manner the soil necessary for root and plant development is removed and the problem will not recur for several years.

Ballast cleaning may be undertaken by using hand forks and screens or by modern methods involving the use of equipment which handles the ballast mechanically. Border and intertrack moles are efficient and effective. Dirt is removed from the ballast and clean stone is returned to its same relative position. Moreover, moles can be used for cleaning several kinds of ballast if appropriate screens are selected for the work.

In addition to removing weeds, the cleaning of ballast improves drainage and track conditions and enhances the appearance of the property. While the cost of cleaning ballast is considerably in excess of other methods of weed eradication, nevertheless the additional advantages gained through its application are well worth while. By establishing a regular program involving the selective cleaning of ballast in specific territories each season, weed growth will be reduced progressively each year and a definite control will be established.

What Paint Gang Organization?

Should paint gangs paint both bridges and buildings or should the painting of these structures be done by separate gangs? Why?

Paint Both

By E. C. Neville
Bridge and Building Master, Canadian National, Toronto, Ont.

Local conditions comprise the largest one of several relative factors that should be taken into consideration in replying to this question. If, for instance, a paint program can be arranged and financed so as to permit the inclusion of sufficient bridge as well as building areas to require the services of separate gangs throughout the year, the separate gang system can be employed economically. However, due to climatic conditions over the major portion of the North American continent, a year-round program of bridge painting could not be carried on effectually with the consequent result that bridge painting gangs could be employed for only a small portion of the year and this plan would eliminate the stabilized employment of these forces.

Where separate painting gangs are required for bridges, it becomes necessary to organize new gangs each year at the beginning of the season. Experience teaches that it is seldom, if ever, possible to assemble a gang with the same personnel each year; hence it is necessary to go through an annual process of expensive training for new men. On the other hand by using the same gangs for painting both bridges and buildings, the work can be so arranged that bridges can be painted during the season best suited for this work, the exterior of buildings can be painted during the spring and fall immediately preceding and following the season of bridge painting and the extreme winter season can be reserved for painting the interior of larger buildings. The interior of smaller roadway buildings can be painted at the same time as the exterior work so as to avoid the necessity of moving the gang back over the same territory.

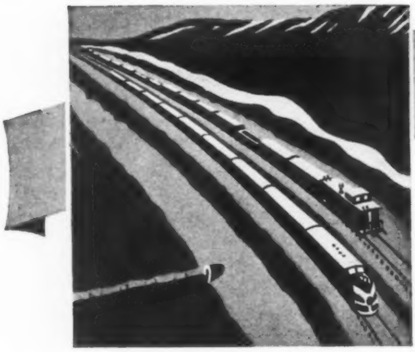
While it may be the belief of some that bridge painting is a separate and more or less specialized branch of the trade, requiring men who have been trained for that particular type of work, it cannot be denied successfully that experienced building painters can be equally as efficient on bridge work, particularly if they have the assurance of reasonably steady employment throughout the year. It has been my experience that it is more economical to do both bridge and building painting with the same gang if a proper program is prepared and consistently followed out.

Increases Production

By L. G. Byrd
Supervisor Bridges and Buildings, Missouri Pacific Lines, Poplar Bluff, Mo.

I see no good reason for employing separate gangs when a program of painting both buildings and steel structures is being carried on. Painting is skill in itself. I have found that a good building painter usually knows how to apply paint to steel bridges and by virtue of his experience will maintain low labor costs and eliminate waste, regardless of whether application is made by brush or spraying equipment. The reverse is also true since a steel bridge painter usually knows how to paint buildings. We still try to follow a program of completing all work progressively in a particular territory on a division or district. The success of a program depends to some extent on the method of its preparation. We try to work to a schedule of painting buildings and bridges out of face; this saves an overlapping of gangs and equipment and also eliminates the unnecessary duplication of movements with outfit cars over the same territory.

By organizing gangs to paint both bridges and buildings, we find that more work of better quality is accomplished. It saves time in transferring equipment, eliminates the purchase of additional equipment which would be necessary if separate gangs were employed and it gives the foreman and his men a broader experience and knowledge of painting. Both rigid and swinging scaffolds are required frequently for the painting of water tanks, coal chutes, steel bridges and many buildings; therefore, when men are carefully selected and properly trained for scaffold work the hazards of falling are reduced to a considerable extent. Moreover, when the same paint gangs are used for painting all types of structures an increase in production is evident which results not only in a saving of labor but in the saving of material as well.



NEWS of the Month

Senate Votes Increased Unemployment Benefits

On July 29, the Senate passed S.3920, Senator Wagner's (New York) bill which would increase benefit payments under the Railroad Unemployment Insurance Act by an estimated 115 per cent. Another bill S.3925, which would have increased benefit payments by about 25 per cent and allowed railroads with a good unemployment record to reduce their taxes, was defeated.

Seniority Protected in Event of Military Service

The Union Pacific, upon approval of the government and other railroads, will grant leaves for military service without loss of seniority on the following terms: 1. Employees who enlist or who are called to service will be granted leaves of absence for the duration of military service. 2. Employees returning from such leaves will retain their seniority and will, subject to physical fitness, be accorded available positions for which they are qualified. 3. Group insurance protection will be adjusted according to the contract in force at the time of enlistment or call to service.

Grand Circle Fares to Be Continued Another Year

The low "grand circle" railroad fares established last year will be continued by the railroads for another year, or until October 31, 1940, because of the success of the plan in the first year of operation, in which 32,500 persons purchased grand circle tickets. Of that number, 25,000 purchased grand circle tour first class tickets ($135) and 7,500 traveled by coach ($90). The grand circle fare plan was inaugurated by the railroads on April 28, 1939, for the purpose of stimulating travel to the New York and San Francisco World Fairs and to points of scenic interest throughout the country.

Transportation Bill Passed by the House

On August 12, the House of Representatives adopted the conference report on S.2009, the omnibus transportation bill, by a vote of 246 to 74 and sent the measure to the Senate. Senator Wheeler has indicated that he will call the measure up in that body at the earliest possible moment, but owing to the extended debate on the conscription bill, said that it would be difficult to say when it would be considered. The bill, which was recommitted by the House this spring, has been modified to include a revised version of the Harrington amendment which would have the effect of limiting its labor-protection provisions, in event of consolidations, to four years. The Miller-Wadsworth minimum rate amendment was eliminated and the Jones export agricultural rate amendment was modified to make it provide that export rates should be granted to agricultural products on the same principle as they are now granted to industrial products. Otherwise the bill as passed by the House is substantially the same as the one, which was "scuttled" last spring, described in the May issue, page 335.

Mexican Workers Object to Economies

The resignation of Juan Guitierrez, general manager, and the board of the National Railways of Mexico, has been forced by the Union of Mexican Railway Workers following a controversy over the proposed changes in working conditions, which were to be placed in effect August 1. The changes were designed to bring about a saving of $1,800,000 pesos a month in accordance with President Cardenas' request. Some of the economies proposed were a reduction of salaries to what they were on May 1, 1938, when the Workers Administration was created; restriction of overtime payments; that persons be compelled to dispose of vacations in time, instead of receiving the equivalent in cash; that a maximum of motive power be utilized by full train loads; re-establishment of a rigid disciplinary regime vested in the heads of the departments, and the suppression of train service tricks or personnel of any department considered unnecessary.

I. C. C. Approves Cost Competition Rates

In a decision on reasonable minimum rates on petroleum products from California to Arizona, the Interstate Commerce Commission recognized the "relatively low cost of rail service" as an "inherent transportation advantage possessed by the rail carriers" and found that those rates which competing motor carriers said were too low, are not less than reasonable minimum rates. In the proceedings, evidence of comparative cost data based on a formula developed by the late Arthur F. White, former head cost analyst and assistant director of the commission's Bureau of Statistics, showed the cost of rail transportation on the Southern Pacific of the Los Angeles-Phoenix petroleum traffic to be 11.1 cents per 100 lb., excluding return on the investment, and 13.7 cents, including a 5¾ per cent return. One trucker's costs for similar traffic were 38.8 cents, excluding return and 40 cents, including return, and another trucker's costs were 37.6 cents and 38.4 cents, respectively. In its decision, the I. C. C. ruled the railroad should not be required to charge a rate above 20 cents.

Urges Quick Amortization Be Allowed for Defense Equipment

Judge R. V. Fletcher, vice-president and general counsel of the Association of American Railroads, appeared before the Senate finance committee and the House committee on ways and means on August 13 to urge that equipment purchased by the railroads for the purpose of co-operating in the national defense program be amortized in the same way in regard to the excess profits tax as facilities acquired for defense purposes by industrial concerns. Judge Fletcher stated that the railroads were anticipating the heavy demands due to the national defense program and had ordered extra equipment for that purpose.

35 Special Trains to Elwood for Willkie Acceptance

On August 17, 35 trains carried more than 20,000 people to Elwood, Ind., on single track lines of the Pennsylvania and the Nickel Plate for the notification ceremonies for Wendell Willkie, candidate for president. Elaborate preparations were carried out by both roads to insure the prompt and efficient handling of this unusual volume of traffic on these lines. The Pennsylvania, which handled 29 trains, established a train dispatcher's office at Elwood to handle the line between Richmond, Ind., and Logansport, and 38 extra operators were provided. Twenty-three block stations were in operation and the lengths of the manual blocks were reduced from 15 to 5 miles. Protection was provided at 185 grade crossings, either by flashing-light signals or watchmen or both, and track patrols were operated over the lines north and south of Elwood. Because of the absence of turning facilities, locomotives on trains from the north were assigned to outbound trains moving to the east and south and vice versa. Emergency coal, water and icing facilities were established and temporary unloading platforms were provided. Each railroad provided a hospital car.

Personal Mention

General

Ralph E. Knapp, division engineer on the Atchison, Topeka & Santa Fe, with headquarters at Las Vegas, N. M., has been promoted to trainmaster, with headquarters at La Junta, Colo. A biographical sketch of the career of Mr. Knapp was published in the July issue, page 463, following his promotion to division engineer on May 1.

Walter E. Heimerdinger, district maintenance engineer of the Chicago, Rock Island & Pacific, with headquarters at Des Moines, Iowa, has been promoted to superintendent at Ft. Worth, Tex. Mr. Heimerdinger was born at Vulcan, Mich., on February 12, 1889, and attended the University of Michigan. He entered the service of the Rock Island in September, 1911, as an assistant on the engineering corps at Davenport, Iowa, and later

Walter E. Heimerdinger

served successively at various points as an inspector, instrumentman, roadmaster, assistant engineer and office engineer. In 1922, he served as resident engineer on the construction of the Rock Island terminals in Omaha, Neb., and in 1924 and 1925, he was locating engineer on the line from Trenton, Mo., to Kansas City. On March 1, 1923, he was promoted to division engineer and served in that capacity at Des Moines, Iowa, Trenton and Cedar Rapids, Iowa. On January 1, 1935, he was appointed roadmaster at Haileyville, Okla., returning to Cedar Rapids as division engineer in January, 1936. Mr. Heimerdinger was promoted to district maintenance engineer, with headquarters at Kansas City, Mo., in July, 1936, and in 1937, he was transferred to Des Moines. His appointment as superintendent at Ft. Worth was effective August 1.

Judson Zimmer, general superintendent and chief engineer of the Fonda, Johnstown & Gloversville, with headquarters at Gloversville, N. Y., has been appointed trustee, with the same headquarters. Mr. Zimmer was born at Gloversville on February 5, 1889, and graduated in civil engineering from Union College in 1910. He entered railway service on September 1, 1910, with the Fonda, Johnstown & Gloversville and served until 1913 as assistant

Judson Zimmer

engineer. From 1913 to 1918, Mr. Zimmer was master mechanic, and from 1918 to 1925, chief engineer. He served as general superintendent and chief engineer from 1925 until his appointment as trustee effective July 23.

Frank Stearns Austin, assistant purchasing agent of the New York Central, and an engineer by training and experience, has been promoted to purchasing agent, with headquarters as before at New York, succeeding **Charles C. Warne,** whose death on July 6 was reported in the August issue. Mr. Austin was born at Lynn, Mass., on November 6, 1886, and was educated at Dartmouth College and Thayer School of Civil Engineering (1909). He entered railroad service on May 31, 1909, as a chainman on the Boston & Albany (New York Central R. R. lessee), serving until 1910 as rodman, transitman and in charge of party surveys. From 1910 to 1913 he was assistant supervisor of track at Pittsfield and Springfield, Mass.; from 1913 to 1917, supervisor of track at Worcester and Boston, Mass.; and from 1917 to 1927, general storekeeper

Frank Stearns Austin

at West Springfield, Mass., all with the Boston & Albany. Mr. Austin served as purchasing agent of the Boston & Albany at Boston from 1927 to 1935 and was assistant purchasing agent of the New York Central from the latter date until his recent promotion to purchasing agent.

George H. Burnette, assistant chief engineer of the Pittsburgh & Lake Erie, with headquarters at Pittsburgh, Pa., has been elected president of the Cambria & Indiana, with headquarters at Philadelphia, Pa. Mr. Burnette was born at Hartford, Ohio, on January 28, 1885, and graduated in civil engineering from Ohio Northern University in 1905. He entered railway service as a chainman with the P. & L. E., serving in this capacity during the summer vacations of 1903 and 1904. From 1905 to 1931, he served with the Monongahela successively as inspector, transitman, draftsman, chief draftsman, assistant engineer, engineer and chief engineer. Mr. Burnette was assistant chief engineer of the P. & L. E. from

George H. Burnette

1931 until his recent election as president of the Cambria & Indiana, with headquarters at Philadelphia, effective August 1.

Engineering

W. R. Armstrong, Jr., supervisor of maintenance of the Nevada Northern, has been appointed chief engineer, with headquarters as before at East Ely, Nev., a change in title.

Luis Reyna, engineer maintenance of way of the National Railways of Mexico, has been promoted to chief engineer, with headquarters at Mexico City, D. F.

H. E. Wilson, roadmaster on the Atchison, Topeka & Santa Fe at Las Vegas, N. M., has been promoted to division engineer, with the same headquarters, succeeding **Ralph E. Knapp,** whose promotion to trainmaster at La Junta, Colo., is announced elsewhere in these columns.

Tom W. Brown, roadmaster on the Chicago, Rock Island & Pacific, with headquarters at Des Moines, Iowa, has been promoted to district maintenance engineer, with the same headquarters, succeeding **W. E. Heimerdinger,** whose promotion to superintendent, with headquarters at Ft. Worth, Tex., is announced elsewhere in these columns.

Harold S. Ashley, assistant division engineer on the Boston & Maine at Greenfield, Mass., has been appointed construction engineer in charge of the relocation

of a section of the main line of the Fitchburg division between Royalston, Mass., and Baldwinville, necessitated by the construction of the Birch Hill dam and reservoir by the federal government. Mr. Ashley's headquarters will be at Baldwinville. **John F. Reilly,** track supervisor of District No. 2 of the Fitchburg division, with headquarters at Greenfield, has been appointed acting assistant division engineer at that point to replace Mr. Ashley.

David Emery Smucker, whose promotion to assistant division engineer of the Fort Wayne division of the Pennsylvania, with headquarters at Fort Wayne, Ind., was announced in the August issue, was born at West Liberty, Ohio, on October 3, 1907, and graduated in civil engineering from Ohio State University in June, 1929. He entered railway service on May 23, 1929, as an assistant on the engineer corps of the Pennsylvania. On August 1, 1929, he was promoted to assistant supervisor at Harrington, Del., and later served in that capacity successively at Lemoyne, Pa., Washington, D. C., and Philadelphia, Pa. Mr. Smucker was promoted to supervisor of track, with headquarters at Clayton, Del., on April 9, 1934, and on October 10, 1935, he was transferred to Perrysville, Md., where he was located until his recent promotion.

Floyd R. Smith, chief draftsman of the Union Railroad, with headquarters at East Pittsburgh, Pa., has been promoted to engineer of bridges, with the same headquarters. Mr. Smith was born at Joliet, Ill., on August 15, 1902, and graduated from Carnegie Institute of Technology. He entered railroad service on July 1, 1922, with the Elgin, Joliet & Eastern, and served as a rodman on maintenance work until February, 1923, when he was promoted to instrumentman on construction work. In April, 1928, he became assistant engineer in the valuation department, analyzing construction contracts for cost data purposes. On February 1, 1930, he went with the Union Railroad as assistant engineer, serving in that capacity until November, 1937, when he was appointed chief draftsman, the position he held until his recent promotion to engineer of bridges.

Floyd R. Smith

Walter A. Blackwell, whose appointment as engineer maintenance of way of the Western Maryland at Baltimore, Md., was reported in the July issue, was born on July 17, 1908, at North East, Md. Mr. Blackwell was graduated from the University of Delaware in 1929 and entered railroad service with the Pennsylvania at Newark, Del., in June, 1925. He went with the Baltimore & Ohio as a track apprentice at Hancock, Md., in October, 1927, and became assistant supervisor on that road at Wheeling, W. Va., in April, 1930, being transferred to Washington, Pa., in July, 1930, and to Pittsburgh, Pa., in October, 1931. Mr. Blackwell became foreman for the Potomac Real Estate & Construction Company at Hancock in May, 1932, and went with W. D. Byron & Sons, Williamsport, Md., in September, 1933, becoming county engineer, Maryland State Roads Commission, Centreville, Md., in September, 1935. He entered the service of the Western Maryland in September, 1937, as bridge and building inspector at Hagerstown, Md., becoming inspector of track at Hagerstown in February, 1940, the position he held until June 12, when he was appointed assistant engineer maintenance of way, at Baltimore, Maryland.

Track

W. H. Bentz, roadmaster on the Chicago & North Western at Chadron, Wyo., has been appointed assistant roadmaster, with headquarters at Casper, Wyo.

J. N. Cheatham has been appointed roadmaster of the Third district of the Washington division of the Union Pacific, with headquarters at Spokane, Wash.

W. E. Dailey has been appointed roadmaster on the St. Louis-San Francisco, with headquarters at Kennett, Mo., succeeding **L. A. Lowry,** who retired on August 26.

W. A. Nimmo, section foreman on the Canadian Pacific, has been promoted to acting roadmaster at Swift Current, Sask., succeeding **W. H. McMurray,** who has been called for active service with the Royal Canadian Signal Corps.

John Burns, roadmaster on the Chicago, Rock Island & Pacific, with headquarters at St. Joseph, Mo., has been transferred temporarily to Eldon, Mo., succeeding **Vaul B. Simpson,** who has been granted a leave of absence because of illness.

L. W. Hogston, section foreman on the Pennsylvania at Columbus, Ohio, has been promoted to acting supervisor of track, with headquarters at Cadillac, Mich., succeeding **A. M. Lood,** who has been granted a leave of absence because of illness.

R. F. P. Bowman, roadmaster on the Canadian Pacific at Lethbridge, Alta., has received a commission in the Royal Canadian Engineers, Canadian Active Service Force, and his territory has been taken care of by a rearrangement of adjoining roadmasters' territories.

L. Bristow, assistant engineer on the Cleveland, Cincinnati, Chicago & St. Louis at Springfield, Ohio, has been promoted to track supervisor at Harrisburg, Ill., replacing **John Gall,** who has been transferred to Lynn, Ind., succeeding **Albert T. Handley,** deceased.

E. L. Snyder, track supervisor on the Atchison, Topeka & Santa Fe at Trinidad, Colo., has been promoted to roadmaster, with headquarters at Las Vegas, N. M., succeeding **H. E. Wilson,** whose promotion to division engineer, with headquarters at Las Vegas, is announced elsewhere in these columns.

E. H. Hayes, assistant roadmaster in charge of a system steel gang on the Chicago, Rock Island & Pacific, has been promoted to roadmaster, with headquarters at Des Moines, Iowa, succeeding **Tom W. Brown,** whose promotion to district maintenance engineer, with the same headquarters, is announced elsewhere in these columns.

G. B. Aydelott, engineering assistant on the Denver & Rio Grande Western at Grand Junction, Colo., has been promoted to roadmaster, with headquarters at Walsenburg, Colo., succeeding **O. M. Flatberg,** who has been transferred to Minturn, Colo. Mr. Flatberg replaces **E. C. Hightower,** who has been transferred to Grand Junction, relieving **H. J. Willard,** who has been granted an indefinite leave of absence.

W. E. Manning, whose promotion to track supervisor on the Southern, with headquarters at Camden, S. C., was announced in the August issue, was born on October 14, 1911, at Sutherlin, Va., and received his higher education at Virginia Polytechnic Institute, graduating in engineering in 1935. He entered railway service with the Southern on November 8, 1937, as a rodman in the office of the chief engineer. On November 1, 1938, he became a student apprentice on the Richmond division, and on October 1, 1939, he was transferred to the Danville division, where he was located at the time of his recent promotion to track supervisor.

John S. Anthony, whose promotion to track supervisor on the Southern, with headquarters at Oxford, N.C., was announced in the July issue, was born on April 26, 1909, at Clinton, N.C. He entered railway service with the Southern in August, 1922, as an extra section laborer, later serving as a station laborer. On September 5, 1927, Mr. Anthony became an extra gang apprentice, which position he held until April 15, 1930, when he was promoted to section foreman. From November 28, 1931, to May 31 of this year, Mr. Anthony served as an extra gang apprentice and as an extra section foreman. His promotion to track supervisor became effective on June 1.

John F. Bourne has been appointed track supervisor of District No. 2 of the New Hampshire division of the Boston & Maine, with headquarters at Concord, N.H., to succeed **John H. Battis,** who has been transferred to District No. 1, with the same headquarters, to replace **Peter J. Gogan,** who has been assigned to other duties. **Frank H. Mason,** general foreman on the Terminal division at Boston, Mass., has been appointed acting track supervisor of District No. 4 of the Fitchburg division, with headquarters at Greenfield, Mass., succeeding **John F. Malloy,** who has been transferred as track supervisor to District No. 2, with the same headquarters. Mr. Malloy succeeds **John F. Reilly,**

whose appointment as acting assistant division engineer is noted elsewhere in these columns. **Arthur A. McMullen,** extra crew foreman, Terminal division, has been promoted to assistant track supervisor of District No. 1 of the New Hampshire division, with headquarters at Concord, succeeding **Harold A. Wickens,** who has been assigned to other duties.

Fred C. Chandler, whose appointment as general roadmaster on the Atlantic Coast Line, with headquarters at Lakeland, Fla., was announced in the July issue, was born at Bakersville, N.C., on March 27, 1884, and attended Washington college. He entered railway service on April 1, 1909, as an apprentice bridge foreman on the Atlantic Coast Line at Lakeland. In November, 1911, he was promoted to bridge foreman with the same headquarters, which position he held until June 1, 1916, when he was further advanced to roadmaster at the same point. On June 1, 1917, Mr. Chandler enlisted as a master engineer in the 17th Engineers (railway) of the A. E. F., and later saw active service on railroad construction work in France, receiving a commission as first lieutenant. On April 1, 1919, he was discharged from the army with a citation from General Pershing for meritorious service. On June 1 of that year he returned to the Atlantic Coast Line as roadmaster at Dunnellon, Fla. On January 1, 1924, he was transferred to Kissimmee, Fla., where he remained until January 1, 1929, when he was advanced to general roadmaster, with headquarters at Rocky Mt., N.C. Following a consolidation of divisions, Mr. Chandler was appointed roadmaster at Tampa, Fla., which position he held until his recent promotion to general roadmaster.

Fred C. Chandler

Bridge and Building

Mark H. Corbin, bridge inspector on the Chicago, Rock Island & Pacific, has been promoted to master carpenter, with headquarters at Cedar Rapids, Iowa, succeeding **P. E. Strate,** who has been transferred to Rock Island, Ill., replacing **N. B. Sears,** assigned to other duties.

Robert P. Seitz, draftsman in the office of the division engineer of the Northern Pacific at Spokane, Wash., has been promoted to assistant supervisor of bridges and buildings at Missoula, Mont., succeeding. **Henry Espeland,** whose promotion to bridge and building supervisor, with headquarters at Fargo, N.D., was announced in the August issue.

Henry Leland Veith, whose promotion to supervisor of bridges and buildings on the Southern, with headquarters at Wilton, Ala., was announced in the July issue, was born at Ellery, Ill., on September 30, 1898, and has taken correspondence school courses in both railway bridge and building work and track work. He entered railway service on February 28, 1922, as an apprentice in the bridge and building department of the St. Louis-Louisville division of the Southern, and was promoted to carpenter helper in August, 1924. A year later he was advanced to mechanic, and on October 19, 1936, he was promoted to bridge and building foreman. Mr. Veith was further advanced to assistant supervisor of bridges and buildings on the Alabama Great Southern (part of the Southern) with headquarters at Birmingham, Ala., on September 1, 1939, the position he held until his recent promotion, which was effective June 24.

Henry Espeland, whose promotion to bridge and building supervisor on the Northern Pacific, with headquarters at Fargo, N.D., was announced in the August issue, was born at Tacoma, Wash., on December 12, 1890, and entered railway service on May 15, 1906, as an office boy in the purchasing department of the Northern Pacific at Tacoma. A few months later, he became a file clerk in the engineering department and in December, 1907, he was appointed a chainman at Tacoma. In November, 1909, he was promoted to rodman at Seattle, Wash., and later served as an inspector, carpenter and bridge inspector. In April, 1922, he was advanced to bridge and building supervisor at Seattle, and in October, 1922, he was appointed assistant bridge and building supervisor. Mr. Espeland was promoted to bridge and building supervisor at Pasco, Wash., in March, 1928, and four years later he was appointed assistant bridge and building supervisor at Missoula, Mont., the position he held until his recent promotion.

Eugene H. Barnhart, whose promotion to general bridge inspector of the Baltimore & Ohio, with headquarters at Cincinnati, Ohio, was announced in the July issue, was born at Sheperdstown, W. Va., on January 3, 1884, and graduated in civil engineering from West Virginia University in 1906. He entered railway service with the Pennsylvania on July 1, 1906, and on March 1, 1907, went with the Baltimore & Ohio as an assistant on the engineering corps at New Castle, Pa. On September 15, 1910, he was promoted to assistant division engineer at New Castle, and on April 28, 1913, he was transferred to Baltimore, Md. Mr. Barnhart was appointed assistant engineer on April 20, 1914, and on February 1, 1916, he was promoted to division engineer maintenance of way, with headquarters at Parkersburg, W. Va. On July 1, 1917, he was advanced to assistant engineer in the general office at Baltimore, Md., and on May 1, 1924, he was appointed industrial engineer for the traffic department. On June 5, 1932, Mr. Barnhart was appointed assistant division engineer at Dayton, Ohio, and four years later he was promoted to division engineer at that point. On March 20, 1938, he was re-appointed assistant division engineer at Dayton, the position he held until his recent promotion.

Special

T. W. Gosling, assistant bridge and building supervisor on the Southern Pacific, has been appointed water and fuel supervisor of the Salt Lake division.

Obituary

Charles L. Van Auken, who retired in 1927 as general foreman of construction for the Chicago & North Western system, died at the age of 83 at Clinton, Iowa, on July 29, three weeks after suffering a broken hip. Mr. Van Auken also served for a number of years as inspector of track on contract track laying for the North Western.

Richard M. Elam, who retired as track supervisor on the Louisville & Nashville, with headquarters at Harlan, Ky., on December 1, 1934, died at his home in Newport, Tenn., on July 19. Mr. Elam was born on September 14, 1872, and entered the service of the L. & N. on February 1, 1890, as a trackman, later serving as an apprentice foreman and section foreman until November 1, 1907, when he went with the Atchison, Topeka & Santa Fe, serving for a time as an apprentice foreman and section foreman in New Mexico. On October 1, 1908, he returned to the L. & N. as a section foreman and in 1918, he was promoted to track supervisor, which position he held until his retirement.

Henry August Bertram, division engineer on the Chesapeake & Ohio, with headquarters at Peru, Ind., whose death at Richmond, Va., on July 6, was announced in the August issue, was born at Greenville, Ohio, on October 14, 1885, and graduated from Wayne Technical Academy, Greenville, Ohio, in 1908. From October, 1908 to June, 1910, Mr. Bertram served as assistant city engineer of Greenville and later as a rodman on a U. S. Government survey in West Virginia. In May, 1910, he entered railway service on the Grand Rapids & Indiana (now part of the Pennsylvania) at Fort Wayne, Ind., and on December 15, 1910, he went with the C. & O. as a rodman on the Chicago division at Peru. He later served as a draftsman, assistant engineer and assistant division engineer at Peru. In June, 1917, he was promoted to division engineer at that point, serving in that capacity and as assistant division engineer until his death.

Bascom E. Haley, who retired as general roadmaster of the Atlantic Coast Line, with headquarters at Lakeland, Fla., on March 31, 1939, died on July 30 at Clearwater, Fla., after having been critically ill for three months. Mr. Haley was born at Dalton, N.C., on August 5, 1878, and during the early years of his career he was employed in farming, coal mining, saw milling and in a printing office and a tobacco factory. In 1901, he entered railway service with the Southern,

serving on a bridge gang. On March 15, 1904, he went with the Atlantic Coast Line as an assistant bridge foreman, being promoted to bridge foreman two years later and becoming a roadmaster in November, 1910. He held the latter position until January, 1918, when he was promoted to general roadmaster, the position he held until his retirement. Mr. Haley was active in the affairs of the Roadmasters' and Maintenance of Way Association of America and served as its president in 1936-37.

Lawrence A. Downs, chairman of the board of the Illinois Central, and an engineer by training and experience, died in Chicago on August 10, of a complication of high blood pressure and heart disease. Mr. Downs was born in Greencastle, Ind., on May 8, 1872, and graduated from Purdue University in 1894. Following graduation he was employed for a short time on the Vandalia Railroad (now part of the Pennsylvania) and in 1896, he joined the engineering corps of the Illinois Central at Chicago as a rodman,

Lawrence A. Downs

being promoted to instrumentman six months later. In 1897, he was appointed assistant engineer and a year later he was advanced to roadmaster, serving in this capacity successively at LaSalle, Ill., Louisville, Ky., New Orleans, La., Clinton, Ill., and Chicago. In March, 1907, he was promoted to assistant chief engineer maintenance of way, and on December 6, 1910, he was appointed superintendent at Ft. Dodge, Iowa, later serving at Dubuque, Iowa, and Louisville. Mr. Downs was advanced to general superintendent of Southern Lines at New Orleans in 1914, and two years later he was transferred to the Northern Lines, with headquarters at Chicago. In 1919, he was appointed assistant general manager and the following year he was elected vice-president and general manager of the Central of Georgia (a subsidiary of the Illinois Central). In 1924, he became president of the Central of Georgia, and in 1926, he returned to the Illinois Central as president. He was elected chairman of the board on December 14, 1938. Mr. Downs was a charter member and past president of the American Railway Engineering Association and in 1929 he was awarded the honorary degree of doctor of engineering from his alma mater, Purdue University.

Association News

Wood-Preservers' Association

The Executive committee will meet at the Hotel Stevens, Chicago, on Tuesday, October 15, to develop a program for the convention next February and to transact other business. The meeting has been called at this time and place to permit the members also to attend the convention of the American Railway Bridge and Building Association, which will be in session.

Bridge and Building Association

The program for the forty-seventh annual convention, which will be held at the Hotel Stevens, Chicago, on October 15-17, is rapidly approaching completion and will be published in the October issue. President A. E. Bechtelheimer is initiating special measures to bring this convention to the attention of bridge, building and water service officers for the purpose of stimulating attendance at the convention.

Bridge and Building Supply Men's Association

Although the invitations to participate in the exhibit to be presented concurrently with the convention of the American Railway Bridge and Building Association at the Hotel Stevens, Chicago, on October 15-17 were sent out during the height of the vacation season, a sufficient number of reservations have already been received to indicate that this exhibit will equal and probably exceed in size those of recent years.

American Railway Engineering Association

The Board of Direction met in Chicago on August 22 to pass upon the budget to be submitted to the Association of American Railroads for appropriations for research and other work to be carried out under the direction of the Engineering division of the A.A.R. during 1941. At this meeting the Board also adopted certain changes in the form of presenting committee reports in the association publications, recommended by Secretary W. S. Lacher in the interest of greater clarification and convenience.

The General committee of the Engineering division, A.A.R., met in Chicago on August 23 to receive and pass upon the budget of the A.R.E.A. and to transact other business of the division.

Five committees met during August, including the following: Waterproofing of Railway Structures, at Chicago, on August 13-14; Economics of Railway Labor, at New York, on August 16; Rules and Organization, at Washington, D. C., on August 19-20; Water Service, Fire Protection and Sanitation, at Chicago, on August 20; and Buildings, at Toronto, Ont., Canada, on August 27-28.

Eight other committees plan meetings during September, six to be held in Chicago concurrently with the Roadmasters convention to afford the members of the committees opportunity to attend sessions of the convention and to visit the exhibit of the Track Supply Association to be held in conjunction therewith. The committees which are to meet in September include the following: Uniform General Contract Forms, at New York, on September 9; Maintenance of Way Work Equipment, at Chicago, on September 9-10; Roadway, at Chicago, on September 9-10; Yards and Terminals, at Buffalo, N. Y., on September 9-10; Rail, at Chicago, on September 11; Highways, at Chicago, on September 11; Track, at Chicago, on September 12 and special committee on Stresses in Railroad Track, in Chicago, on September 12.

Loose-leaf supplements to the Manual, incorporating action taken at the 1940 convention, were mailed to members during the month. The first 24 plans of the complete revision of the portfolio of Trackwork Plans have been printed and are available to those desiring to purchase them.

Track Supply Association

A total of 54 companies have now arranged for 74 spaces in the exhibit of the Track Supply Association, these numbers comparing with 45 companies and 63 spaces at the exhibit last year. The companies which have arranged for space since the publication of the original list in the June issue and supplementary companies in the July and August issues are as follows:

Chicago Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., New York
Moto Mower Co., Chicago
Reade Manufacturing Co., Jersey City, New Jersey.

Roadmasters Association

President G. L. Sitton has called a meeting of the Executive committee at the Hotel Stevens, Chicago, at 6:30 p.m. on Monday evening, September 9, to check final plans for the convention and to clean up the year's work before turning the affairs over to the next administration. The program for the convention is complete as published in the August issue, pages 526-7. In addition, plans have been made for an inspection by special train on Thursday afternoon of the Chicago terminals of the C. M. St. P. & P., where opportunity will be afforded to observe the methods employed and the materials used. This inspection will be in charge of the local maintenance officers who will point out special features of interest.

Supply Trade News

General

The Osmose Wood Preserving Company, Buffalo, N.Y., has opened a branch office in the Ernst and Cramner Building, Denver, Colo., under the jurisdiction of **D. Kamphausen.** The new office will handle the company's business in the Rocky Mountain region.

The Rails Company, New Haven, Conn., has acquired from the **Rail Maintenance Corporation,** New York, the exclusive rights to the strip-welding process for building up rail ends. Railroads may now make strip welds under license agreements with the Rails Company, or the

Continued on page 590

"Read what this 'B & B' Committee has to say about BRIDGE MAINTENANCE"

Oils or greasy coatings with rust inhibitive substances which can be applied over old scale and rust, if applied regularly, afford maintenance men the best opportunity to keep their bridges in first class condition.

From "Bridge Painting Problems Resulting from Deferred Maintenance"—Report of Committee, American Railway Bridge & Building Association

This statement is based on a thorough, unbiased study of bridge maintenance problems on leading railroads. It reaffirms the basic economy of the NO-OX-ID method of protecting bridge steelwork.

NO-OX-ID is a non-drying coating that stops rust in two ways. First, it mechanically excludes moisture and oxygen by maintaining a plastic coating that cannot crack or chip. Second, it contains chemical inhibitors that prevent corrosion under this protective mechanical film.

NO-OX-ID makes thorough cleaning unnecessary. Just brush or scrape off loose rust scale and apply NO-OX-ID "A" Special. NO-OX-ID penetrates to the metal, prevents further corrosion, and loosens remaining rust scale. Write for data book.

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work may be done under contract either by this company directly or through sub-licenses issued to existing contracting organizations. In licensing railroads to use the strip-welding process The Rails Company is prepared to supervise the work and to permit the use of a grinding attachment which was especially designed for use in connection with this process.

Personal

E. W. Backes, sales engineer of the **Rail Joint Company** at Chicago, has been appointed sales engineer for the **Carnegie-Illinois Steel Corporation,** with the same headquarters.

J. B. Emerson, formerly engineer of tests for the Rail committee of the American Railway Engineering Association and later associated with the passenger car axle research conducted by the A. A. R., Mechanical division, at the Timken Roller Bearing Company's laboratory at Canton, Ohio, has become affiliated with the **Pittsburgh Testing Laboratory's** railroad inspection department, with headquarters in Chicago.

G. Cook Kimball, executive vice-president, **United States Steel Corporation of Delaware,** with headquarters at Chicago, will temporarily make his headquarters at Washington, D.C., effective August 15, in the interest of further co-ordinating United States Steel activities arising from increasing requirements of the national defense program. During his temporary absence from Chicago, **C. H. Rhodes,** vice-president, will take over the activities and duties which have been under Mr. Kimball's direction.

Howard R. Salisbury, assistant manager of the **Air Reduction Company** at Philadelphia, Pa., has been appointed manager, succeeding **William W. Barnes,** who has retired after 30 years active service with the industry, and **H. B. Seydel,** assistant sales manager of the New York district, has been appointed assistant manager at Philadelphia. Mr. Salisbury has been connected with Airco for 15 years. He was manager at Bettendorf, Iowa, for two years and has been assistant manager at Philadelphia for the past six years.

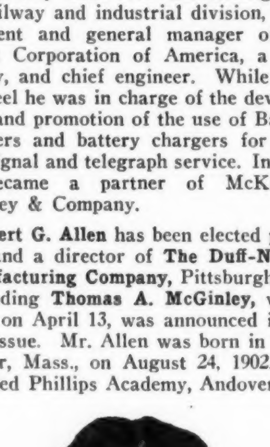
Mr. Barnes first became associated with the oxyacetylene industry in 1910 when he joined the Davis-Bournonville Company as Philadelphia sales manager. In 1922, when Davis-Bournonville merged with Air Reduction, Mr. Barnes became Air Reduction manager at Philadelphia, a position he held until his retirement.

Clinton E. Stryker, of McKinsey, Kearney & Co., Chicago, has resigned to become vice-president and assistant to the president of the **Nordberg Manufacturing Company.** He graduated from Armour Institute of Technology in 1917 and from that year until 1919 was employed as a testing engineer by the Commonwealth Edison Company, Chicago. From 1920 to 1923, he was assistant professor of electrical engineering at Armour Institute of Technology and at the same time served as chief engineer for the Ozone Pure Arifier Company and as electrical engineer for the Underwriters Laboratories. In 1923, he entered the employ of the Fansteel Products Company, now the Fansteel Metallurgical Corporation, North Chicago, Ill., as an electrical engineer and

Clinton E. Stryker

subsequently until 1935 was manager of the railway and industrial division, vice-president and general manager of the Ramet Corporation of America, a subsidiary, and chief engineer. While with Fansteel he was in charge of the development and promotion of the use of Balkite rectifiers and battery chargers for railway signal and telegraph service. In 1935, he became a partner of McKinsey, Kearney & Company.

Robert G. Allen has been elected president and a director of **The Duff-Norton Manufacturing Company,** Pittsburgh, Pa., succeeding **Thomas A. McGinley,** whose death on April 13, was announced in the May issue. Mr. Allen was born in Winchester, Mass., on August 24, 1902. He attended Phillips Academy, Andover, and



Robert G. Allen

Harvard University, majoring in economics, and taking post-graduate work at Harvard Business School. Upon completion of his college courses, Mr. Allen obtained a position with the Walworth Company in South Boston, Mass., entering the foundries as a laborer to learn this phase of the business. From that department he went to the machine shops, and then up through the other divisions of the company. In 1927, he was sent to Columbus, Ohio, to represent the Walworth Company in the sales field, and two years later he was advanced to sales manager, with headquarters at Greensburg, Pa. In 1936, Mr. Allen resigned to become a candidate for Congress. He was elected and served in the National House of Representatives for four years, during which period he served as a member of the Foreign Affairs Committee. After his re-election in 1938, he notified his constituents that he would leave public life at the expiration of his term. On July 15, 1940, he was elected president of the Duff-Norton Manufacturing Company, Pittsburgh, and also of its subsidiary company, the Canadian Duff-Norton Company, Ltd., Coaticook, Que.

Trade Publications

Painting of Creosoted Wood.—This is the title of an illustrated leaflet issued by the Wood Preserving Corporation, Pittsburgh, Pa., which discusses a number of considerations involved in painted creosoted wood and which emphasizes the necessity of seasoning such wood after treatment and before it is painted. The leaflet contains a list of seven directions for painting creosoted poles and posts with aluminum paint.

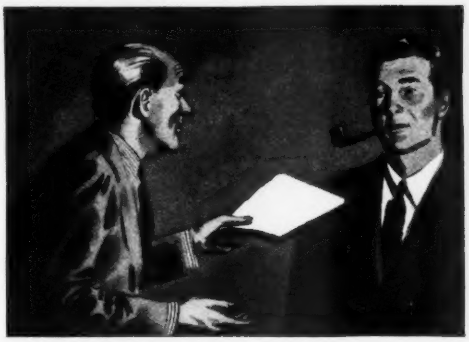
Peerless Pumps—The Peerless Pump Division of Food Machinery Corporation, Los Angeles, Cal., has published a 64-page catalog with this title, covering the full line of Peerless Pumps, which includes water or oil lubricated turbine pumps, propeller pumps, mine pumps and the new Peerless Hi-Lift pump. Ten different types of turbine pump heads are illustrated and full details are presented on the water or oil lubrication of all models. The catalog also presents 12 pages of hydraulic engineering data of value to the water service engineer.

Pittsburgh Screw and Bolt Company—A 96-page loose leaf catalog presenting specifications, price lists, contents of standard containers and weights for the complete line of bolts, nuts, rivets and rods manufactured by the Pittsburgh Screw and Bolt Corporation, Pittsburgh, Pa., has been issued by that company. The catalog also contains a section of general information and suggestions for ordering bolts and a section on rivets including the standard specifications of the American Society for Testing Materials for boiler-rivet steel and boiler rivets, and for structural rivets. The catalog is attractively printed, is wire bound with an imitation leather cover and is completely indexed.

Arc-Welding Electrodes—A 24-page booklet, No. ADW, has been published by the Wilson Welder & Metals Company, New York, entitled, Wilson Arc Welding Electrodes. The booklet, which has been prepared as a guide in helping to make selections of the proper electrodes for all classifications of welding work, reviews the general description, use and physical properties of the various Wilson electrodes for numerous welding purposes. The booklet also includes a section on welding symbols and instructions for their use, as published by the American Welding Society. It is attractively printed in color and illustrated with numerous photographs of welds and test specimens.

"The best records have been made by Pitch and Gravel Roofs"

(in survey of 7,500 roofs on damage by hail)



ROOF DAMAGE by hail usually comes when hail stones puncture raised "blisters" on a roof and thus permit water to enter. This may cause damage not only to the roof, but to the roof deck and to contents of the building as well. What has been the record on this? Here is the latest report:

"OUR ORGANIZATION kept records on damage done to roofs by hail during the five years ending last fall."

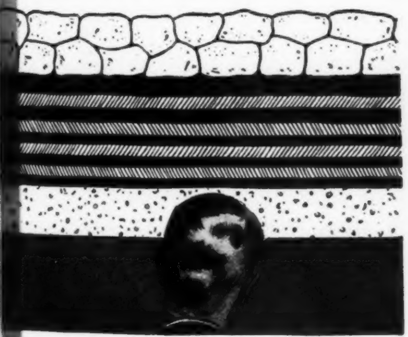
"How many roofs did your records cover?"

"About 7,500."

"WE FOUND INJURY from hail in a considerable number of roofs that were not protected by slag or gravel surfaces. But only one of all the tar and slag or tar and gravel roofs had suffered any damage."

"How serious was the damage?"

"On the roofs without a slag or gravel surface, the average damage was about $1,000.00. On the *one* tar and slag roof, it was less than $150.00."



WHEN YOU HEAR of built-up roofs that have lasted 20, 30 or 40 years, you usually find they are roofs of coal tar pitch and slag or gravel. That has been no accident. Coal tar pitch has inherent properties that make it best for roofs . . . and for waterproofing.

"WHY did the coal tar pitch roofs do so well?"

"Partly because the slag surface protects them from injury. Partly also because tar roofs have a property known as "cold flow" which enables the tar to self-heal any small surface breaks and thus keep out the water."

"WHEN YOU REALIZE that the tar roof's superior ability to resist hail is coupled with a similar ability to resist wind damage, sun damage, water damage, and fire, you can see how important it is to specify coal tar pitch for your roofs."

OTHER KOPPERS PRODUCTS: Tarmac Road Tars for paving drives, parking areas, walks, etc. . . . Bituminous-base Paints . . . Pressure-treated Piling and other timber products.

KOPPERS COAL TAR ROOFING—KOPPERS COAL TAR WATERPROOFING

KOPPERS COMPANY, PITTSBURGH, PA.

use **K O P P E R S** *products*

ECONOMICAL FLEXIBILITY

BURRO FLEXIBILITY . . . . . permits using the Crane under practically any conditions. When working under traffic, fast travel speed over 20 miles an hour, facilitates clearing for trains, or if desired, the Crane can be set off the track. Low overall height permits using the Crane mounted on a car in a work train.

WIDE OPERATING RANGE . . . keeps the Burro busy throughout the year. Rail relaying, track building or dismantling, ditch cleaning, scrap handling, bridge repairing, rail loading or unloading, pile driving, coal handling, are some of the Crane's many jobs.

Top illustration shows scrap handling with magnet, and Crane is mounted on flat car. Lower view shows Crane building new track, hauling its own cars of rail, etc.

TRACK SUPPLY ASSOCIATION
SEPT. 9-12, 1940
EXHIBITOR
HOTEL STEVENS · CHICAGO
ROADMASTERS CONVENTION

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BURRO CRANES

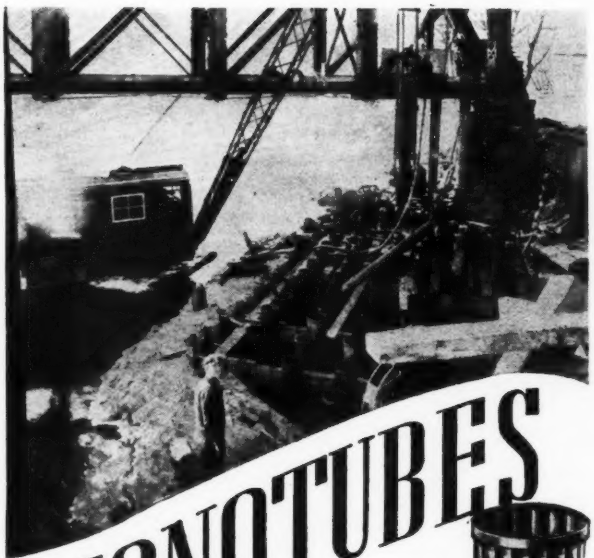
Model 15 . . . . Model 30

BURRO ANTI-SLIP RAIL TONGS

Write for Bulletin

CULLEN-FRIESTEDT COMPANY

1301 So. Kilbourn Ave. Chicago, Illinois

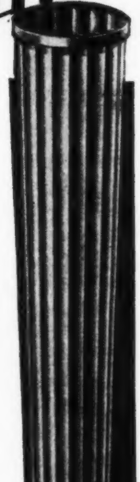


MONOTUBES

Keep

PILING JOBS

Rolling on Schedule



● Whether it's a new or under traffic piling job, Monotubes will help you save time and money. These cold rolled, tapered steel piles requiring no core or mandrel can be driven speedily with standard equipment. Their light weight, plus the fact they can be fabricated in sections, if desired, permits installation without interference to traffic.

Monotubes are available in a wide range of tapers, gauges and lengths. Thorough inspection of driven shells affords positive proof of their integrity, and when filled with concrete, produce piles of proven strength and durability.

Write for copy of Catalog No. 68A. It contains complete information on the Monotube Method of Pile Construction.

THE UNION METAL MFG. CO.
CANTON, OHIO

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